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NATIONAL MUSEUMS AND GALLERIES IN BRITAIN

THE collecting instinct is strong in nearly all human beings of all ages. It takes various forms at different periods of our lives, but is always present. But collecting involves collections, and thus museums and art galleries became a necessary adjunct to civilization as a place to deposit the vast accumulations of objects made by individuals and organisations. Originally museums were simply buildings in which such accumulations could be deposited and conserved; and many a museum has been burdened by Sir *X*'s collection of African trophies or Mr. *Y*'s cabinets of marine shells from the Pacific.

But museums have changed, and are changing, rapidly. To the tasks of collecting and conserving has been added the duty of displaying these collections for the educational and recreational benefits of the community. No better evidence of this changed state of affairs, so far as the national museums and galleries of Great Britain are concerned, could be found than in the recently issued third report of the Standing Commission on Museums and Art Galleries*.

The Standing Commission was set up by the Treasury in 1931 with the following terms of reference: "(1) to advise generally on questions relevant to the most effective development of the National Institutions as a whole, and on any specific questions which may be referred to them from time to time; (2) to promote co-operation between the National Institutions themselves and between the National and Provincial Institutions; and (3) to stimulate the generosity and direct the efforts of those who aspire to become public benefactors".

The Commission is therefore an advisory and not an executive body. Unfortunately, it only deals with the national museums and galleries, and we are pleased to note that the National Museum of Wales is included for the first time. The first report of the Commission was issued in 1933 and the second in 1938. At that time it was hoped to report at five-yearly intervals; but unfortunately the War upset this arrangement, and the present publication covers a ten-year period. At the outset it can be said without hesitation that it is an impressive record of solid achievement and a reasoned statement of aspirations for the future.

The report is divided into three sections. In the first, many will read with interest a connected account of the measures taken for the evacuation and preservation of the vast collections in the national museums and galleries. It is a record of brilliant achievement, but was followed by intense reaction and a feeling of frustration by the trustees and directors concerned. The report relates how temporary and special exhibitions were quickly initiated, and how appreciative was the response of the public to these cultural war-time efforts. So much so indeed that, with the return of more normal conditions,

* The National Museums and Galleries: the War Years and After. Third Report of the Standing Commission on Museums and Galleries. Pp. 52+12 plates. (London: H.M. Stationery Office, 1948.) 1*s*. 6*d*. net.

special exhibitions have become part of the permanent policy of most of the museums and galleries in Britain.

The total war damage suffered by national museum buildings has been estimated at £1,294,000; those most seriously affected include the British, Natural History, Science, and Imperial War Museums, and the National and Tate Galleries. Fortunately, relatively little damage was suffered by their contents, except for the loss of some 200,000 books in the British Museum Library and about 30,000 volumes of provincial newspapers at Hendon.

In so far as reconstruction is concerned, it is interesting to note that Bethnal Green Museum is to reopen as a type of provincial museum, with material of all kinds taken from the collections at the Victoria and Albert Museum, and "with the same policy of constantly changing exhibitions on a theme employed at the parent Museum". We await with interest the result of this experiment to establish and organise a branch national museum.

In the second part of the report the Commission surveys immediate and long-term building needs and attempts to place them in order of priority. It considers that the most urgent needs in building are in connexion with the national libraries of England and Scotland. It is recommended that as a long-term project a new building for the National Library should be sited near the British Museum; but for the immediate needs of the Library it is considered that additional book-stacks could be erected on the present site. Further, it is gratifying to note that the Commission recommends that the British Museum and Library should continue under the same administration; we believe that separation would be fatal to the efficiency of both institutions. At the Newspaper Library at Hendon, storage structures are to be built immediately. The erection of a permanent microfilm laboratory—the first specially designed building of this type in the world—is recommended, and it is stated that the Rockefeller Foundation is generously contributing equipment costing 56,000 dollars. In Scotland, it is remarked that the present congestion in the National Library is desperate, and new buildings should be put in hand at the earliest possible moment. It is also recommended that, in order of priority, should follow the completion of the second half of the Entomological Block at the British Museum (Natural History); the rebuilding of the centre block of the Science Museum; and a lecture hall and cinema for the Royal Scottish Museum.

Long-term building needs were also considered by the Commission, thus indicating its desire that future planning should be definitely related to a policy. Its recommendations also include the new National Library at Bloomsbury already mentioned, a new gallery of modern art and museum of antiquities in Edinburgh, a new building for the London Museum and extensions to the Imperial War Museum, Science Museum, Royal Scottish Museum and the National Museum of Wales. In addition, there is the project for a Scottish folk museum, though it is stated that the contemplation of a similar museum for England remains the vaguest aspiration. This is perfectly true, so far as a national folk museum and folk park is concerned, but many professional museum directors are of the opinion that the problem would be better tackled and solved by the establishment of provincial folk museums and parks in selected regions, rather than by the creation of a central national institution for the whole of England; local initiative and enterprise have already started at least two such centres, at Bristol and Plymouth. It is unfortunate, to say the least, that it is not within the province of some national organisation to plan such museums on a cultural basis rather than to rely on the present rather haphazard siting. Reference is, of course, made in the report to the splendid achievement of the establishment and opening by the National Museum of Wales of the Folk Museum at St. Fagans.

The allocation of sites for museums and galleries in South Kensington is reviewed, especially in relation to the proposed retention of the ethnographical collections at Bloomsbury, and the possible transfer to the same building of the Indian collections now housed at South Kensington. This would appear to be a logical and practical necessity.

The third and last section of the report deals with recent developments and future needs in the national museum field. Among acquisitions for the nation mention must be made of Apsley House and Ham House; the former by a generous gift from the Duke of Wellington, through which the nation has obtained an extremely interesting collection of works of art and personalia of historic interest in the setting of an early nineteenth-century mansion. Ham House and its magnificent collection of furniture of the period of Charles II has now been made available to the nation, and, like Apsley House, will be administered by the Victoria and Albert Museum as a branch national museum. It will also be noted with widespread approval that the British Museum (Natural History) proposes to launch a scientific periodical devoted to the publication of researches by the staff based on the museum collections; at the present time the well-known *Novitates Zoologicæ* meets this need only in so far as the Departments of Zoology and Entomology are concerned.

Concerning the staff of the national museums, the Commission rightly states that directors and higher keepers, or their equivalent, should be authorities in their particular subject. It is not enough for them to be merely experts, for the position of Great Britain in the realms of art and science depends in no small measure on the capacity for scholarship and learning shown by the higher members of the staffs of our national museums and galleries. But the gap between these members and the routine technical workers is uneconomical, both in its financial and cultural aspects. The Commission urges the introduction of a grade of professional worker who would be capable of carrying out the many relatively routine tasks incident to museum work, although he might not have sufficient training or experience to enable him to act as an authority on any subject or be able to make decisions at a high level. On the other hand, it is no doubt visualized that some at least of this new middle grade would, by initiative and study, fit

themselves for appointment to the higher posts. Such reflexions apply, indeed, not only to the national institutions but also to the larger provincial museums and galleries, where senior officials at present are often burdened with much routine work which could be delegated to others.

This leads to a disappointing feature of the report where the Commission, in endeavouring to carry out the second of its terms of reference, merely expresses a hope that good relations exist between the national and provincial museums and galleries. Actually there is close co-operation between the national and provincial institutions, but this is chiefly due to the goodwill and fellowship which exist between the respective directors and their staffs. It is also in no small measure due to the activities of the Museums Association, the regional federations, and the Carnegie United Kingdom Trustees. All these bodies within their respective spheres have done much to mould the museum movement in Great Britain, and it is unfortunate that their influence and importance is not recognized in the report.

Freedom is the first essential in the development of museums, as it is for universities and indeed all cultural bodies. On the other hand, it is desirable that some controlling body should be responsible for their distribution and broad policy, and to some extent for their financial liabilities. The national museums and galleries are directly responsible to various trustees or a Minister of State, and the Standing Commission has the task of advising with regard to their many activities. But the mass of provincial museums—public and private—have no such unification of advice. It would appear desirable that the national and provincial museums should be under the same broad control, for essentially they are both seeking to serve the community in similar ways. Does the solution of this problem lie in extending the terms of reference of the Standing Commission and at the same time giving it executive control, or should a new body called, say, the Museum and Art Gallery Grants Committee, and comparable to the University Grants Committee, be set up? The latter, with its new responsibilities, holds the purse-strings—represented by the Exchequer grant for university education in Britain—and yet upholds university autonomy. The formation of a similar body in relation to the national and provincial museums could ensure their efficient maintenance, while exerting a measure of guidance without intruding on their administration. This is an urgent matter and should be decided in the relatively near future. The Museums Association, in a memorandum published in 1945, advocated the setting up of a new body on these lines, though it was quite prepared to consider the alternative of extending the powers of the Standing Commission.

Museums are changing rapidly; the earlier musty storehouses of the 'nineties' are becoming centres of culture and learning. They are now vital organisations, of service to the educational and recreational needs of Britain, and it is important that the broad lines of their high-level organisation should be determined as soon as possible.

NORSEMAN VOYAGES TO NORTH AMERICA

The Wineland Voyages

By John R. Swanton. (Smithsonian Miscellaneous Collections, Vol. 107, No. 12: Publication 3906.) Pp. ii+81. (Washington, D.C.: Smithsonian Institution, 1947.) n.p.

THE problem of the Norse discoveries in America is one of the most fascinating in all history. Although in the past some people have, like Nansen, dismissed the reports in the saga of Eric the Red and the Flatey book as myths, there can be few students to-day who doubt that the Norsemen visited America on at least two occasions. The present volume is the work of an author who has had experience in unravelling the conflicting accounts left by other expeditions of discovery, and he uses the technique which he had evolved for such research work on the solution of this old and thorny problem. The result is, to my mind, the most successful of all the numerous books so far produced on the subject. He holds that even the most careless report of an expedition must contain some accurate information, and, with this most reasonable assumption, is not prepared to reject any account as valueless. This is sound common sense and completely praiseworthy. Although he admits that the old accounts are too sketchy for absolute certainty in the identification of any particular camp site or anchorage, yet he contends that the general areas visited by Karlsefni's early eleventh-century expedition can be deduced with some reasonable probability of success. He follows Steensby in equating Helluland with northern Labrador and Markland with southern Labrador. He places the Wonderstrands on the Labrador coast of the Gulf of St. Lawrence and suggests that Streamfirth lay somewhere in the region of the Mingan River in the St. Lawrence estuary. As to the exact location of Wineland itself, he is much less certain and wavers between Nova Scotia and New England with a bias towards the latter.

The whole matter is treated with the greatest care and fairness of judgment and should be consulted by anyone interested in the subject. There are points, however, which strike the reader as needing greater attention. One is the question of distances. We are dealing with the traditions of seafaring men and would expect that when the lengths of passages are preserved they would be remembered with at least as great accuracy as descriptions of woods and lakes. Helluland appears to have been two days sail from Greenland. Karlsefni went far north up the Greenland coast to get a fair slant across the northerly winds which had baffled Thorstein's previous expedition. It seems scarcely possible that a small square-rigged sailing vessel can have hit any coast but Baffin Land in the time allowed for it. If this is sound reasoning, everything has to be looked for farther north, which brings us to the second point. Changes of climate are dismissed as being generally considered improbable. But if we are to accept von Post's theories of climatic cycles, they are not improbable at all. In other words, the climate of the eleventh century may well have been more genial than it is at present. This is to some extent confirmed by the southerly movement of the Eskimos following their prey down the west coast of Greenland until they came in contact with the Norse settlers, and by

the fourteenth-century report of increased ice on the east coast of Greenland. It would probably have more than a little influence on the distribution of the fauna and flora, and in turn would affect the distribution of Indian and Eskimo communities.

T. C. LETHBRIDGE

POWER-STATION CHEMISTRY

Boiler House and Power Station Chemistry

By Dr. Wilfrid Francis. Second edition. Pp. xiv + 274 + 9 plates. (London: Edward Arnold and Co., 1947.) 21*s*. net.

DURING recent years, with the latest designs of power-station boilers raising steam at high pressures and temperatures, and with the difficulties in obtaining regular supplies of fuels of the desired qualities, the problems confronting those responsible for the generation of steam and electricity have increased in intensity and become more varied in character. The book by Dr. Wilfred Francis, the first edition of which was published in 1940, is intended for "chemists, students of fuel technology, and operators of boiler plant and power stations". It provides a useful background of information on the properties and combustion of coals, and on such subjects as the treatment of boiler feed water, types of oil required for turbines, switches and transformers, and the treatment of flue gases to remove grit and sulphur compounds. Part 1 of the book is written in a style to suit those with "no profound knowledge of chemistry", while Part 2 gives a detailed description of standard methods of chemical analyses used regularly by power-station chemists, with some modifications based on the author's experience.

In the second edition, the author endeavours to anticipate the changes in boiler-house and power-station practice which in his view are likely to be made in the future in consequence of recent advances in coal research. He urges the efficient use of coal as a source of chemicals, while serving as the raw material for prepared fuels; but the argument is somewhat marred by the fact that his example is the combined coal carbonization and boiler plant erected and operated some years ago at the Dunston power station. As the author mentions, this plant was not commercially successful, and was shut down in 1931.

Few will share his view that many processes are available for washing flue gases economically and efficiently so that the sulphur may be recovered in useful form without increasing the cost of generation of electricity. No process has been tried on a large scale for recovering sulphur in a really useful form from the flue gases of power stations; and no process so far suggested shows any definite promise of operation without increasing the cost of electricity. Cost figures given for those processes of flue-gas washing, without sulphur recovery, which have been operated on a full scale, seem to be based largely on 1938 prices. At present-day prices, the cost of these processes is equivalent to an addition of seven or eight shillings on every ton of coal burnt in the boilers.

Great advances have recently been made, as a result of chemical investigation and supervision, in mitigating the serious difficulties caused by deposits of solid matter on the external heating surfaces of power-station boilers. This important problem, which is related to the composition of the coal and conditions of combustion, is not mentioned. Admittedly the investigations are very recent, and no doubt the author will include a chapter on this subject in a future edition, even if limitations of space necessitate curtailing the chapter on the constitution of coal.

This useful book occupies a place not filled by any other book in this field of technology.

A. PARKER

AN INTRODUCTION TO STELLAR DYNAMICS

Einführung in die Dynamik von Sternsystemen

Von Prof. Dr. E. von der Pahlen. (Lehrbücher der Monographien aus dem Gebiete der exakten Wissenschaften, 10; Astronomisch-geophysikalische Reihe, Band 1.) Pp. 240. (Bern: Verlag Birkhäuser, 1947.) 36 Swiss francs.

THE subject of stellar dynamics is concerned with the general properties of the motions of assemblages of stars. Just as in gas theory it is not possible to follow the motions of individual molecules, but the properties of the motions of all the molecules are discussed by statistical methods, so in stellar dynamics it is not the motions of individual stars that are of interest but the general statistical properties. An assemblage of stars moving under their mutual gravitation is not, however, analogous to an ordinary gas, for collisions are practically non-existent; the effect of close encounters is to cause a slow approach toward equipartition of energy; but it can be shown that the time required for equipartition to be attained is of the order of a hundred times larger than the ages of the stars on current views. The motions of stars are therefore analogous to those of molecules in a gas theory where there is a gravitational potential but no collisions.

This volume provides an excellent introduction to the subject. A limited number of problems are discussed and considered in relation to the data provided by observation. The book is divided into three parts. The first part outlines the general theory; the effect of close encounters is considered and the time of relaxation derived. The basic equations of stellar dynamics are then formulated and the general method of solution for stationary states discussed. The special cases of axial and spherically symmetrical systems are discussed and the transformation of equations into general orthogonal co-ordinates obtained.

The second part considers the application of the equations to the galactic system. The observational evidence concerning the solar motion, star streaming, the asymmetry of motions of the high-velocity stars, and galactic rotation is summarized. The general theory of galactic rotation is then discussed and related to the observational data. It is concluded that they cannot be fully explained on the assumption of the stationary state, and possible modifications of the simple theory are outlined.

The third part deals with the extra galactic star systems. Hubble's classification, according to the shape of the system, which suggests a definite evolutionary sequence, is described. The general theory for stationary and non-stationary systems with internal motions is then outlined. Special discussions are given of the possible mode of transition from an

elliptical system to a spiral or barred-spiral system, and of the origin of the spiral arms in spiral systems.

The reader who has mastered this volume will be adequately prepared for the study of more advanced treatises or of the original papers, to which adequate references are given. The author's exposition is very clear, and the volume is well printed; but unfortunately the price is so high that it will be beyond the means of many students.

H. SPENCER JONES

THE YOSEMITE

One Hundred Years in Yosemite

The Story of a Great Park and its Friends. By Carl Parcher Russell. Pp. xviii+226+28 plates. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1947.) 21*s.* net.

DR. C. P. RUSSELL, the author of this book, who is now chief naturalist of the United States National Park Service, was for many years stationed in the Yosemite, and devoted much time to research into the history of the area and of those associated with it. The book is based upon one with the same title which he wrote in 1930, and incorporates much new material which, with never-flagging zeal, he brought together during the intervening years. A foreword has been contributed by the director of the National Park Service.

The Yosemite valley lies some 140 miles inland from San Francisco in the highlands of the Sierra Nevada, and is notable both for its magnificent scenery—one of the outstanding features being the famous Big Tree Grove—and for its interesting and romantic history. It became known through the prospectors who explored the outlying region for the mineral wealth which it was found to contain. As the result of the persuasive efforts of a few public-spirited persons it was decided to reserve the area for public enjoyment, and in 1864 by Act of Congress the State of California was given possession of an extensive district, including the Yosemite Valley and the Mariposa Grove, for permanent preservation. Unhappily, the existence of private rights had been overlooked or ignored, and great difficulties were encountered at first before a settlement was reached. Later, the growing threat to the surrounding area by the encroachment of sheep-farmers led to a movement for an enlargement of the State park. Owing to local opposition it failed, but the zone in question, which was larger than the original park, was set aside as reserved forest lands by the Federal Government in 1876 and administered as a national park. The inconvenience of dual control within the same district was obvious, and in 1905 the State offered its grant back to the Federal Government, the offer being accepted by Congress in 1906. Although in the strict sense the Yosemite was not a national park until then, as a public open space it preceded by some years the first national park, the Yellowstone, established in 1872.

Dr. Russell has spared no effort in investigating the history of the early pioneers, and does not gloss over the lawlessness which was too often a feature of those days. It should be noted that, while the needs of tourists visiting the national park for recreation are fully catered for, scientific observations and their interpretation have received adequate attention, and a museum, illustrating the historical and scientific aspects of the region, has been established. The area of the national park, as now delimited, is 1,100 square miles.

The book contains a useful bibliography, and is well illustrated. G. F. H. S.

A MANUAL OF DERMATOLOGY

The Skin Diseases

A Manual for Practitioners and Students. By Dr. James Marshall. Pp. xi + 363 + 8 plates. (London: Macmillan and Co., Ltd., 1948.) 30*s.* net.

THIS new manual on dermatology is intended as a guide to diagnosis for students and as a reference book for practitioners. It is written by an author who, being primarily a venereologist, believes with some of the French school of dermatologists that syphilis is one of the most important of skin diseases, that dermatology and syphilology are inseparable, and that a comprehensive study of dermatology could be constructed on the sole basis of syphilis and its differential diagnosis. The work is written as a companion to the author's book on "The Venereal Diseases". Undoubtedly it is brave of Marshall not merely to take this attitude, but also to fling down the gauntlet in the face of critics, reviewers and other readers in the first seven lines of the book, for much water has passed under the bridges of the Seine since this view was first proposed, and many dermatologists in Britain—while not denying that the study of a systemic disease having protean manifestations has some importance—would regard the challenge as too demoded to consider seriously.

Inevitably Marshall has experienced the same difficulty in the arrangement of his book that has haunted the writers of all small manuals of dermatology. This difficulty arises from the lack of an adequate classification of skin diseases, and leads to such anomalies as the chapter on bacillary infections in the book at present under review, wherein there is a complete omission of any reference to tuberculous diseases of the skin. In Marshall's book the reader, having completed a brief study of leprosy, has to peruse some fifty-five pages concerning syphilis before returning to the maladies caused by that bacillus to which Koch gave his name, and which—for the British dermatologist—are of greater interest and much greater difficulty than lues.

The book is fully illustrated; but unfortunately—probably owing to difficulties in the supply of suitable paper—some of the illustrations are not very clear. The text of the work is concise, the author's approach to the subject is dogmatic; but in many instances the instructions concerning treatment are too brief. It is pleasant to find a chapter on the infectious fevers wherein is given a summary for guidance in diagnosis.

Contrary to the statement made on the dust-cover, the whole field of dermatology is not considered (in fact, to attempt to cajole the prospective purchaser with such a statement is quite unwerrantable); but the book has cost the author very many hours of laborious work, and undoubtedly he will be a churlish reader who does not find many matters of value and interest in it. R. M. B. MACKENNA

Igneous Minerals and Rocks

By Ernest E. Wahlstrom. Pp. ix + 367. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 33*s.* net.

THIS book is intended for two classes of reader, namely, the student beginning the study of the igneous rocks, and the geologist seeking a refresher course. As a result, the beginner will need careful guidance in his selection of the essentials from the mass of information presented for the expert. Either class of reader is assumed to have a good knowledge of optical mineralogy, presumably from the author's "Optical Crystallography".

In the first part of the work, the minerals, including those of contamination and alteration origin, that make up the igneous rocks are described in detail and illustrated by excellent photographs of thin sections. Adequate accounts are given of all the techniques used in mineral identification, and the author emphasizes the importance of not relying on thin section examination only. The test of this kind of instruction is the manner of treatment of the identification of the plagioclase felspars—the author passes the test with ease. This part of the book contains tables for the identification of minerals in thin section and by the use of immersion media.

In Part 2 the igneous rocks are dealt with. A brief account of their geological occurrence is first presented. It may be noted that here the author, forgetting the etymology of the good English word, uses 'dyke' in an unusual sense. He decides that rocks can be classified wholly on the basis of their mineral composition and texture, so that genetic considerations are neglected. Some results are, for example, the separation of quartz-dolerites and quartz-gabbros from the dolerites and gabbros, and the placing of granite and rhyolite in one family. His compromise classification is semi-quantitative, the main divisions, six in number, being based on the presence of the following minerals: felspars and silica minerals; felspars; felspars with less felspathoids; felspathoids with less felspar; felspathoids; ferromagnesian minerals. Photographs of hand specimens and thin sections of igneous rocks are provided, and also an outline scheme for the identification of the igneous rocks under the microscope. Much of the book reads like a lexicon but, with petrogenesis deliberately excluded, that is to be expected. Here is, at least, an excellent petrographic lexicon. H. H. R.

Electric-Motor Control Gear: Starting, Protection and Speed

By J. L. Watts. Pp. 96. (London: Iliffe and Sons, Ltd., 1948.) 5*s.* net.

THIS book is arranged in the form of notes on motors and control gear, and contains a lot of useful information in a small space. It is intended chiefly for electricians engaged in the maintenance and installation of such plant. No attempt is made to cover any aspects of design, but starting conditions and their effect on acceleration and control gear are discussed briefly, graphical examples being given for squirrel-cage and slip-ring motors. A valuable feature is the inclusion of speed-torque characteristics of various types of single-phase motors. There is a useful chapter on protective gear, and the final chapter gives examples of connexions of typical control gear for D.C., single-phase and three-phase motors.

There are a number of imperfections which should be rectified before the book is reprinted. For example, the obsolete symbol *C* is used for current, *F* for power factor, and a queer nameless symbol is used for flux instead of the usual Φ. Symbols and abbreviations are all printed in Roman type, and in consequence V appears both as a symbol and an abbreviation. Non-standard British Standards Specification terms are also used, such as capacity (instead of capacitance), no-volt release (instead of under-voltage release), overload release (instead of over-current release). Some weird mathematical expressions also occur, such as $\frac{230\ \text{V}}{13\ \Omega} = 17{\cdot}7\ \text{A}$. Some of the diagrams relating to motor characteristics and speed control require more explanation, for example, Figs. 15, 16, 17, 46, 49, and some connexion diagrams require revision. A. T. D.

La vie des requins

Par P. Budker. (Histoires naturelles, 7.) Pp. 278 + 22 plates. (Paris: Libr. Gallimard, 1947.) 325 francs.

THIS small volume is admirable in its simplicity and interest, the secret of its success being the author's undoubted liking, if not affection, for these huge sharks which are regarded with horror and disgust by many. The subject is approached with respect for the shark and admiration for its wonderful power and form, so perfectly fitted for its mode of life. Certainly a dogfish swimming in an aquarium tank is an unforgettable sight. The numerous illustrations are good, both plates and text figures, and the various chapters cover much ground: classification, morphology, anatomy, food habits and 'les mangeurs d'homme', freshwater sharks, pilots and remoras, history, and shark fisheries and utilization. As man-eaters the large sharks are apparently much less dangerous than is usually supposed. They undoubtedly eat man, especially in certain regions, but they are easily frightened, and it has been stated that they are the most cowardly of all animals that fly, run or swim. This is No. 7 of a series of "Histoires naturelles", and is thoroughly recommended to all lovers of natural history.

Nature and Prevention of Plant Diseases

By Dr. K. Starr Chester. (Blakiston Books on Agriculture.) Second edition. Pp. xi + 525. (London: H. K. Lewis and Co., Ltd., 1947.) 25*s.* net.

THE second edition of Dr. K. Starr Chester's well-known introductory text-book on plant pathology is extensively revised, and an eight-page glossary has been added. The chapters on bacterial and virus diseases have considerable additions. In some other chapters the text has been successfully pruned to improve the balance of the presentation. Chapter 20, on the control of plant diseases, contains a valuable tabulation of new fungicides, and an account of such recent methods of seed disinfection as the slurry and pelleting treatments. The work is intended for American students, and more than 90 per cent of the references to literature are North American.

The book omits mention of some of the major crop diseases of Britain, including virus yellows of sugar beet, and the take-all (*Ophiobolus*) and eyespot (*Cercosporella*) diseases of wheat. Lodging of wheat is described as primarily a light-deficiency disease. However, the book might be used as a text in Great Britain if judiciously amended.

THE SEVERN BRIDGE AERODYNAMIC RESEARCH

By Dr. R. A. FRAZER, F.R.S.
National Physical Laboratory

EXPERIMENTS on the behaviour of model suspension bridges in wind are being carried out in a large wind tunnel at Thurleigh, Bedfordshire. The tests form part of an investigation, which was undertaken by the National Physical Laboratory of the Department of Scientific and Industrial Research, on behalf of the Ministry of Transport, to give guidance in the design of the proposed Severn Suspension Bridge. The work was begun early in 1946, and it is not only important to bridge engineers but also presents many features of interest to research workers in aerodynamics.

A properly designed suspension bridge will remain relatively steady when exposed to any wind. An unsatisfactory bridge may oscillate in a number of different ways, which will depend on the wind speed and the wind direction. Bridges with deep solid web stiffening girders, for example, are liable to both vertical and torsional oscillations. With the first type of movement (also called 'galloping') the deck platform and stiffening structure bend up and down, and the two suspension cables swing equally and in step; with the other type, the platform and girder twist about the roadway centre line (approximately), and the two cables move equally but in opposite phases. Each oscillation type may appear, at appropriate frequencies, in a variety of different wave forms.

Oscillations are further distinguished as being 'symmetrical' or 'antisymmetrical'. In the first case, the movements at corresponding positions of the two equal half-spans of the bridge are equal and in phase, and in the other case they are equal but in anti-phase. With antisymmetrical oscillations no vertical displacements occur at the centre of the span, but the cables there tend to slide to and fro along the span relative to the stiffening girder. This movement is particularly objectionable as the suspenders at the centre span are short, so that high stresses can be imposed. A centre tie, bonding the cables to the girders, has been used on some bridges to prevent this type of oscillation.

The well-known film of the Tacoma Narrows Bridge made by American scientific workers gives a valuable record of the 'galloping' which occurred during the four months the bridge was used for traffic, and of the antisymmetrical torsional oscillation which suddenly appeared in a wind of only 42 miles per hour and broke the main bridge structure in an hour. This bridge was fitted with a centre tie. The repeated 'galloping' contributed to this disaster, as it eventually weakened the centre tie and so allowed the torsional oscillation to develop.

It may not be possible in practice to adopt every measure which is shown by aerodynamic investigation to be helpful in preventing oscillations of suspension bridges in wind. Measures may be advantageous from the aerodynamic point of view, but unacceptable from the points of view of structural design or erection. They may displease the architect, or have to be rejected as a possible nuisance to users of the bridge. Thus the choice of the most practicable and economical safeguards will depend to some extent on compromises.

Experiments with models carried out in both Great Britain and the United States provide clear evidence that a high degree of stability can be gained by proper attention to the detailed shape and arrangement of the deck platform and stiffening structure. It is also advantageous to increase the natural frequencies of the bridge, because this tends to raise the wind speeds at which oscillations can set in. From this point of view, heavy bridges are not necessarily the safest bridges. When weight is increased, additional overall rigidity is derived from the suspension systems; but unless weight is economically used in also stiffening the suspended structure, the natural frequencies may not be improved.

The research programme in Great Britain is following the same broad lines as wind tunnel investigations which have been carried out at the Engineering Experiment Station of the University of Washington (Seattle) during the last eight years. Two types of bridge model are used, distinguished as 'sectional' and 'full'. A sectional model is a rigid representation of a sample length of the deck platform and stiffening structure (say 300 ft.), and is sufficiently compact to be accommodated in an ordinary wind tunnel. The model is mounted in the tunnel

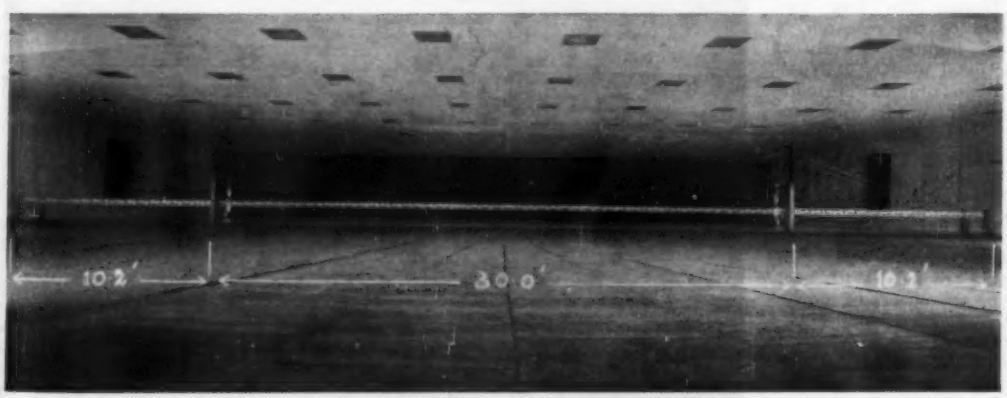

Fig. 1. Full model bridge mounted in tunnel test-chamber

Fig. 2 (*a*). Front view of tunnel, showing test-chamber behind bell-mouth and optical patterns on intake screen

under spring constraints with freedom to move vertically or to swing about a central axis, and its tendencies to develop oscillations in these freedoms are observed for a range of wind speeds and wind inclinations. In this way the effects of changes of the structural form on stability can be studied systematically, and the results can be used to find the most promising types of section. A full model is a suitably scaled reproduction of the complete bridge, made in such a way that it is deformed and moves similarly to its parent. Full models involve great constructional difficulties and require an abnormally large wind tunnel. However, with knowledge of the subject in its present incomplete state, they are necessary to confirm whether predictions based on the simpler experimental method are really satisfactory.

During the first two years of the research, a large number of tests of sectional models of truss-stiffened bridges were made in a 4 ft. × 4 ft. wind tunnel at Teddington. These covered a gradual transition in design from wide bridges with two or four separate roadway tracks to narrower bridges with overhung side-walks and cycle tracks. With each type the effects of numerous structural modifications (for example, increases of the gaps separating tracks, or changes of the roadway stringers or handrails) were studied. The main *provisional* conclusions are summarized in a paper entitled "An Experimental Investigation of the Aerodynamic Stability of Suspension Bridges", recently presented by Mr. C. Scruton at the Third Congress of the International Association for Bridge and Structural Engineers. Design features mentioned as being advantageous against torsional oscillations of a truss-stiffened bridge include the separation of traffic lanes by open slots or gratings, the use of truss-type roadway stringers, and castellation of handrails.

The basic principle in the design of a full model is consistent scaling of all the forces taking part in oscillations. These are due to inertia, gravity, elasticity and wind. The appropriate scale for forces is decided by the fact that the model and parent systems must have equal densities at corresponding positions. Equality of the air densities is essential, because tests in a pressurized wind tunnel would involve prohibitive difficulties. Hence also the structural densities must be equal. From this it follows that weights and masses of structural parts, and thus gravitational restoring forces, must be proportional to the cube of the linear scale. A true model copy of the actual bridge would thus satisfy all requirements so far as concerns shape, mass, and weight; but it would be disproportionately stiff. To correct this inconsistency various devices are adopted, such as a reduction

Fig. 2 (*b*). Rear view of tunnel, showing contraction and diffuser

of the cross-sectional areas of structural members, or the use of suitably adjusted spring mountings for model parts. The only remaining acting forces are due to wind. There is good evidence that with bridge sections these forces arise mainly from pressure and only to a small extent from viscous action, and so will vary as surface area times the square of the airspeed. For consistent scaling, therefore, tunnel airspeeds are reduced in proportion to the square root of the linear scale.

For the Severn Bridge investigations a linear scale of 1/100 was adopted for models. Thus elastic stiffnesses (measured as loads per unit angular deflexion) and weights are to scale $1/10^6$, and wind speeds are to scale 1/10. Oscillations on the model have ten times the full-scale frequency.

The structural form of the full model at present under test (Fig. 1) is based on one of the earlier types of sectional models. It represents a truss-stiffened bridge 107 ft. wide with two separate roadway tracks, each 40 ft. wide. The length of centre span is 3,000 ft. and the total span 5,040 ft. Constructed of light rigid components with steel spring connexions adjusted to give the correct overall elastic stiffnesses, the model offers wide scope for modifications of structural form. A second model with a larger main span will be based on a form of section more closely representing that of the final Severn Bridge design.

To enable the full models to be tested in winds blowing from any horizontal direction, a wind tunnel with a working chamber 60 ft. long, 60 ft. wide and 7 ft. high had to be designed and constructed. A maximum tunnel airspeed of about 20 ft. per sec. (corresponding to a wind of 136 miles per hour on full-scale) was considered to be adequate. Available information on other tunnels gave valuable guidance in the aerodynamic design, and a final control on design was provided by experiments carried out at the National Physical Laboratory on a 1/12-scale model of the tunnel and its enclosing hangar to ensure good airflow distribution and performance. The actual tunnel (Fig. 2) was structurally designed, and erected in its 240 ft. × 120 ft. hangar, by the Bridge Section and Eastern Engineering Division of the Ministry of Transport. In the construction careful attention was paid to simplicity, low cost, and future recoverability of materials.

The test chamber, which is parallel-sided, extends back 60 ft. from the tunnel bell-mouth, and a turn-table flush with the floor carries models round to any desired angle of yaw. Aft of the test chamber the rectangular cross-section contracts smoothly over a further length of 60 ft. to a circular annulus 12 ft. in diameter containing a single two-bladed fan driven by a 130-h.p. electric motor. After passing through the fan, the air is discharged back into the hangar through a diffuser of length 30 ft. Provision for upward and downward inclinations of the wind over the model is made by an arrangement of adjustable wind deflectors fitted to the floor and roof of the test chamber.

One side of the experimental programme consists of a study of the influence of wind speed, wind direction, structural form and tower flexibility on frequency, wave form, and type of oscillation. Another relates to the vital question as to whether satisfactory predictions can be made of the behaviour of full model bridges from data supplied by tests of sectional models alone. This difficult problem involves a very careful assessment of the parts contributed by frictional and structural damping forces on the two types of system, and has already received much attention in the United States.

The consulting engineers, Messrs. Mott, Hay and Anderson and Messrs. Freeman, Fox and Partners, are collaborating closely in the planning of the research, and free interchange of information between Great Britain and the United States is also proving very valuable.

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GEOLOGY AND RESERVES OF LEAD AND ZINC ORES: A WORLD SURVEY

By Dr. K. C. DUNHAM
Geological Survey of Great Britain

AT the eighteenth session of the International Geological Congress, held in London last summer, after being postponed from 1940, the proceedings of Section F were devoted to a consideration of the geology, paragenesis and reserves of the ores of lead and zinc. Up to the time of the Second World War, it had been assumed generally that resources of these base metals, while not inexhaustible, would be sufficient for many generations, even though the rate of annual world production had risen from 200,000 long tons lead metal and 120,000 long tons zinc metal in 1860 to 900,000 and 500,000 tons respectively at the turn of the century, and had reached nearly 2,000,000 tons of each metal in 1939. The searching examinations of their mineral resources carried out by the belligerent countries during the War, coupled with an emphasis upon production rather than exploration and development during hostilities, led to the realization of an immediate shortage of both metals when the War ended, and to the expression of grave doubts as to the future position. The subject chosen for Section F was, therefore, of immediate practical interest in 1948.

It had been the practice in connexion with previous sessions of the Congress to issue a volume covering the resources of some useful mineral; thus pyrite and phosphates were considered as part of the work of the fourteenth session (Madrid, 1926), and copper was dealt with by the sixteenth session (United States, 1933). Such volumes appeared after the session, and the subject was generally not discussed during the proceedings. On the present occasion a different procedure has been followed. Papers were invited from eminent authorities describing major lead- and zinc-producing districts which were chosen to represent the principal genetic types. Twenty-three such papers were published before the session as a symposium in a limited edition, which has already been exhausted. These, together with twelve additional papers presented during the proceedings, will be published with the discussion as a volume of the *Comptes rendus*.

In an introduction to the symposium, an attempt was made to bring together, in tabular form, the salient facts of the geology of the 114 principal lead and zinc fields of the world, together with such published data on reserves as are available. The statistical data naturally vary very much in completeness and

reliability, but they serve to make possible some appraisal of the order of magnitude of potential supplies, and their geological and geographical distribution. The figures suggest that nineteen years production of lead at the present rate, and twenty-six years of zinc production, can be foreseen. These figures should not, of course, be regarded as representing the ultimate world resources of the ores; development of known deposits and exploration for new sources will doubtless add further reserves. The usefulness of the symposium and discussion must be judged from the contribution it makes to the better understanding of the conditions under which the deposits may be expected to occur.

Although few countries are completely lacking in deposits of lead and zinc ores, the major producing fields have a restricted and patchy distribution. In opening the discussion the chairman, Prof. W. R. Jones, pointed out that 70 per cent of world production comes from only five countries, and nearly half the world's supply is from North America.

Concentrations of lead and zinc of a sufficient tenor to repay extraction are thus comparatively rare features of the earth's crust. They originated under special combinations of geological conditions, and their investigation involves most of the branches of the science, particularly stratigraphy, tectonic geology, petrography and mineralogy. The hypothesis that in a great majority of instances the metals were carried by hot ('hydrothermal') solutions became firmly established at the close of last century, the origin of such solutions being sought in the residual fluids left after the crystallization of igneous magmas, particularly those of granitic composition. The present-day preoccupation of a group of petrologists with the origin of granites by metasomatism in the solid state, without development of liquid magmas, raises anew the question of the derivation and concentration of metals such as lead and zinc. For the adherents of the granitization school, the metals must either be supplied directly by emanations of deep-seated origin or they must be concentrated from the rocks transformed during the metasomatic process. For the latter possibility no adequate mechanism has yet been proposed. Such views have not yet made much headway among geologists whose main concern is with metalliferous deposits, though N. H. Magnusson ("Symposium", p. 210) remarks in his description of the Ammeberg field in central Sweden: ". . . several metals have been driven out from the sediments and from older sulphide ores and concentrated outside the front of the veined gneisses (the migmatite front). In this way . . . zinc and lead have been precipitated, especially where the migmatite front is sharp. . . ." In other regions of intense metamorphism, where gneissoid rocks are the hosts of the lead–zinc deposits, the metallic sulphides are accompanied by hydrous silicates such as chlorite, chloritoid, sericite and talc, which point to deposition in a cooler and more hydrous environment than that obtaining during the regional metamorphic process under which the host rocks originated. Examples of such deposits include the 'skols' of northern Sweden, described by Erland Grip, and the great Broken Hill deposits of New South Wales. Discussing the latter, J. K. Gustafson has stated his belief that the 'lode' is a hypothermal replacement formed long after folding and regional metamorphism at much shallower depths and under reduced temperature and pressure conditions. Similar arguments might be applied to the deposits around Noranda in north-western Quebec, now important sources of zinc. In all these presumed high-temperature lead–zinc sulphide deposits, and in the unique zinc oxide–silicate masses of Franklin, New Jersey, described by A. W. Pinger, injection of pegmatites appears to have preceded, or perhaps in some instances accompanied, the emplacement of the ores.

The clearest evidence of the association of lead and zinc ore-formation with igneous intrusions is found among the pyrometasomatic deposits concentrated in the aureoles of stocks of granitic to monzonitic composition. Such occurrences formed the subject of W. Lindgren's important paper published in 1904, which probably contributed more than any other work to the establishment of the magmatic-hydrothermal hypothesis. Deposits of this character, prominent among the occurrences in Mexico described by J. Gonzalez Reyna, are exemplified also in the symposium by the Bingham Canyon area, Utah, described by R. N. Hunt and H. G. Peacock, and by the Central District, New Mexico, described by S. G. Lasky and A. D. Hoagland. In these occurrences, the metallic sulphides occur with silicates developed in the rocks, particularly limestones, as a result of heat and migrant fluids from the igneous intrusions. In many cases the sulphide deposits extend out beyond the silicate zone into otherwise unaltered limestones.

The remarkable metallization displayed by certain areas in the Peruvian Andes, described by the geological staff of the Cerro de Pasco Copper Corporation, illustrates alike the close relation between intrusions and zoned mineralization, and the occurrence of blende and galena under conditions of varying temperature and pressure. At Cerro de Pasco these ores occur as lead–zinc-rich portions of a great pyritic replacement body, crescentic in shape, formed along a fault where it is tangential to a volcanic vent which is partly breccia-filled and partly invaded by quartz-monzonite porphyry.

A close relation to granite intrusion, here of Hercynian age, is displayed by the veins and limestone replacements in Sardinia, according to the late V. Novarese, S. Vardabasso and P. Zuffardi; but here the ores are seldom associated with silicates.

That metasomatism played a dominant part in the emplacement of the lead–zinc deposits themselves is agreed by all observers. Vein-deposits, produced by the simple filling of fissures, are of slight importance compared with the great concentrations produced where the sulphides replace the substance of the host rocks. In the hypothermal and pyrometasomatic types already mentioned, gneisses, schists, metamorphosed volcanics and pyroclastics, crystalline and silicated limestones have all been subjected to sulphide metasomatism. Among mesothermal deposits, the mineralizing solutions or emanations have displayed the capacity to replace great bodies of lava—as at Buchans, Newfoundland, or Bawdwin, Burma—or shale, as at Mount Isa, Queensland, described by S. R. Carter. Among lower temperature deposits, limestone assumes greater importance as a host rock. Presumably as a result of its solubility, it carries large metasomatic bodies in places where adjacent argillaceous or arenaceous rocks are barren, or mineralized only along restricted fissures. In such cases an overlying shale may appear to cause the localization of replacement deposits in limestone; R. A. Mackay has suggested that this is due to ultra-filtration of colloids, the solutions escaping through the shale, and the metallic ions remaining behind in the limestone. The metasomatism may, moreover,

be selective to a marked degree; for example, at Pioche, Nevada (E. B. Young), a 50-ft. limestone in a series of rocks 2,000 ft. thick, containing many other limestone beds, has yielded 90 per cent of the production of the district. Some of the great lead and zinc deposits of the world belong to the low-temperature, limestone-replacement type; characteristically they show no demonstrable connexion with igneous intrusions, though they are currently believed by many workers to result from the activity of far-travelled hydrothermal solutions of igneous origin. The Mississippi Valley districts, covered by C. H. Behre, jun., A. V. Heyl, jun., and E. T. McKnight, the deposits of East Tennessee, described by A. L. Brokaw, and the lead–zinc field of Upper Silesia (now entirely in Poland), described by J. Zwierzycki, are outstanding examples. The important but as yet largely undeveloped resources of French Morocco and Tunis belong, at least in part, to the same type; descriptions of these were contributed by G. Jouravsky, F. Permingeat, J. Agard and P. Sainfeld. The prolific deposits of Spain and of the Alpine Trias are likewise low-temperature limestone replacements, exemplified by D. di Colbertaldo's account of the Raibl area, Cave del Predil, Italy.

Disseminations of galena and blende, in the Bunter Sandstone of the Rhineland, formerly believed to be of sedimentary origin, were likewise assigned by F. Behrend to hydrothermal solutions. On the other hand, T. Deans brought forward evidence to show that in certain Zechstein sediments in Lower Silesia and in Germany, as well as in their equivalents in western Europe and north-eastern England, galena and blende occur in significant (though not at present economic) quantities. Their widespread distribution was held to render untenable any hypothesis other than that of syngenesis.

Lead and zinc deposits thus occur (1) in hypothermal and pyrometasomatic parageneses, where the associated minerals include silicates indicating moderate to high temperatures, (2) in mesothermal deposits, including metasomatized lavas and argillaceous rocks, (3) in leptothermal and telethermal deposits of low-temperature origin, many of which have replaced limestone, (4) in less concentrated form as syngenetic constituents of sediments. The available statistical data place the most substantial world reserves of both lead and zinc in deposits of hypothermal type (35 and 32 per cent respectively); mesothermal types come next with 24 per cent and 20 per cent respectively, while the telethermal represent 17 and 23 per cent.

The immediate contribution which the geologist is able to make to the exploration for, and exploitation of, the deposits is in the elucidation of their structural relationships, particularly of those factors which determined the channels by which the mineralizing fluids gained access to the host rocks. In the ancient metamorphic rocks, complex fold-structures are found to have pre-dated the mineralization, but to have determined the positions of the ore-bodies at mines such as the Sullivan, British Columbia (C. O. Swanson) and the Flin Flon, Manitoba (T. L. Tanton and J. M. Harrison). The remarkable replacement deposits at Stantrg, Yugoslavia (C. B. Forgan), are related to folded contacts between schists and limestone, and intrusive contacts between an andesitic breccia-pipe and limestone. In the Taxco district of Mexico (G. M. Fowler, R. M. Hernon and E. A. Stone) a belt of mineralized shale follows a low-dipping thrust-fault between schist and limestone, and steep fissure-veins also occur in the limestone. In the Upper Mississippi Valley district (A. V. Heyl, jun., and C. H. Behre, jun.), minor folds, elliptical in plan, have had an important influence upon the distribution of oreshoots. In Sardinia the veins follow the axial directions of the Hercynian folds, whereas in the recently discovered Mpanda field, Tanganyika (J. de La Vallee Poussin and R. B. McConnell), the most promising deposit lies near the intersection of north–south and east–west shear belts. Many other structural relationships described in the symposium and discussion show the very diverse conditions under which lead and zinc deposits may be formed. In orogenic belts they are, like most other sulphide concentrations, late features in the tectonic cycle. The lower-temperature types may also occur in epi-continental regions, remote from areas of profound tectonic disturbances, and apparently not accompanying manifestations of plutonism. In terms of the classification of P. Niggli, the loci of deposition of lead–zinc deposits may be intramagmatic, perimagmatic, apomagmatic or cryptomagmatic. The deposits may be formed at hypabyssal or epicrustal depths. No single general rule will cover them; advance in our understanding of their origin will depend upon the accumulation of still more data upon individual districts and occurrences, many of which are still inadequately described.

Perhaps the most disappointing feature of the proceedings was the lack of any contribution from geologists in the U.S.S.R. to a symposium in which all other significant producing countries were represented.

SCIENTIFIC CENTENARIES IN 1949

By Engineer Captain EDGAR C. SMITH, O.B.E., R.N.

SIDE by side in the choir of the chapel of Merton College, Oxford, are the graves of Dr. John Bainbridge (1582–1643), the first Savilian professor of astronomy, and Henry Briggs (1561–1631), the first Savilian professor of geometry, while close at hand is the monument to Sir Henry Savile, the founder of the chairs, who was born four hundred years ago next November and who died at Eton College on February 19, 1621. Born near Halifax, Yorkshire, Savile matriculated at Brasenose College, Oxford, became learned in science and the classics, travelled abroad, was reader in Greek to Queen Elizabeth, from 1585 was warden of Merton College, and from 1596 also provost of Eton. He was knighted by James I in 1604 and in that year had the misfortune to lose his only son. Among his closest friends was Sir Thomas Bodley (1545–1613), founder of the Bodleian Library. Savile published some fine editions of Greek works, and in 1619 devoted a part of his fortune to the establishment of the two famous chairs "open to mathematicians from any part of christendom". Savile himself acted for a short time as professor of geometry, but then relinquished the chair to Briggs, who had been professor of geometry in Gresham College, London, since its foundation in 1596. When the news of Savile's death reached Oxford, the "Vice-Chancellor and the Doctors ordered a speech to be publicly made in Honour of him; which was done by Mr. Thomas Gosse, of Christ Church, and shortly afterwards published. . . ."

Another benefactor of learning, but a century later, was Elihu Yale, who was born on April 5, 1649, and died on July 8, 1721. His birthplace was Boston, Massachusetts, but he was educated at the Merchant Taylors' School, London. Entering the service of the Hon. East India Company, he rose to be governor of Fort St. George, Madras, and in 1699 became a governor of the Company. In later years he had an estate at Plas Gronow (Goronwy), Wrexham, Denbighshire, but he died in London. His tomb in Wrexham Parish Church bears an epitaph beginning

"Born in America, in Europe bred,
In Africa travell'd and in Asia wed,
Where long he liv'd and thriv'd ;
in London dead . . ."

The tomb was renovated in 1877, and the original stone bearing this inscription is now at Yale. It was Yale's gifts that led to a school in New Haven, Connecticut, being named Yale College, the title Yale University being authorized in 1887.

Turning the pages of another century to the records of 1749, the deaths and births of that year recall, among others, workers who helped to spread a knowledge of the discoveries of Newton, and others who applied those discoveries to problems of great importance. Among the former were the Welsh mathematician William Jones, F.R.S. (1675–1749), the Italian Abbé Antonio Conti (1677–1749) and the learned French woman, Gabrielle Emilie, Marquise de Chatelet-Lomont (1706–49), while in the latter group are Pierre-Simon, Marquis de Laplace (1749–1827), Jean-Baptiste Joseph-Delambre (1749–1822) and the Rev. Samuel Vince (1749–1821). Jones began life as a naval schoolmaster, but settling in London, he taught mathematics, published in 1711 a "Treatise on Fluxions" and was one of the committee which inquired into the invention of the calculus. The same matter engaged the attention of the Abbé Conti, who came to London in 1715 to observe the total eclipse of the sun, and wrote what was probably one of the last letters received by Leibniz on the calculus controversy. The Marquise de Chatelet was one of the most learned women of her age, but she is also remembered for her friendship with Voltaire, through whom, no doubt, she wrote her "Institutions de Physique" (1740) and a translation of Newton's "Principia". She was only forty-three when she died. Of Laplace it is necessary to say little. When, in 1927, the centenary of his death and the bicentenary of the death of Newton were commemorated in Paris, M. Emile Picard began his address at the Sorbonne by saying: "Nous voudrions commémorer ce double anniversaire, en rappelant la vie et l'œuvre du fondateur de la mécanique céleste et du plus illustre continuateur de son œuvre ; on aura ainsi une esquisse d'un des plus beaux chapitres de l'histoire de la Science". The life of Delambre covered much the same period as that of Laplace, but throughout the Revolutionary era he continued his astronomical studies, which culminated in his great "History" published in five volumes. Laplace was the son of a small farmer ; the Rev. Samuel Vince was the son of a Suffolk bricklayer, and both owed their start in life to liberally minded benefactors. Enabled to go to Cambridge, Vince in 1775 was senior wrangler and Smith's prizeman, and from 1796 until his death was Plumian professor of astronomy and natural philosophy. He experimented and wrote on many subjects, and in 1780 was Copley medallist of the Royal Society. Another mathematician and natural philosopher of the same period was Patrick Copland (1749–1822), professor at the Marischal College, Aberdeen, who travelled, formed a small science museum and was the first in the north of Scotland to give a series of popular lectures on natural philosophy.

Contemporaries of some of the above include Thomas Godfrey (1704–49), the Philadelphia glazier who received from the Royal Society a reward for his independent invention of the quadrant; William Ged (1690–1749), the Edinburgh goldsmith who reduced himself to indigence in his endeavour to develop his invention of stereotypy ; Peter Elvius (1710–49), the Swedish astronomer and metallurgist who became the secretary of the Academy of Science, Stockholm, founded in 1739 ; Daniel Rutherford (1749–1819), who is remembered for his observations in 1772 on the gas afterwards named nitrogen, and for his work as professor of botany at Edinburgh ; Tiberius Cavallo, F.R.S. (1749–1809), who, coming to London in 1771 on business, settled here and became known for his many experiments and writings on electricity ; and Joseph Bramah (1749–1814), the very ingenious mechanician and inventor who introduced the hydraulic press and whose London workshop was a training school for the rising generation of mechanicians.

Attention may also be directed to the career of Dr. Edward Jenner, who was born at Berkeley, Gloucestershire, on May 17, 1749, and died there on January 26, 1823. As a medical student at Sodbury, Jenner's attention was turned to the subject of protection against smallpox. In 1780 he began experiments, and sixteen years later, in 1796, performed his first inoculation, and so, as Sir Richard Gregory wrote, "opened the door to a new realm of remedies for disease".

Carrying the survey forward yet another century, to 1849, Sir Mark Isambard Brunel and Jacob Perkins, who both died in that year, were almost as famous in the engineering world as Laplace and Delambre had been in the worlds of mathematics and astronomy. Brunel was of French parentage, being born near Rouen in 1769. He served in the French Navy, spent six years in the United States and came to England in 1799. Perkins, on the other hand, came of an old Colonial family and was born in Newburyport, Mass., in 1766, but settled in England in 1818. His machinery for printing bank-notes and postage stamps was a notable achievement, and his pioneering work on the use of high-pressure steam and mechanical refrigeration was outstanding. Brunel, like Perkins, was an experimenter ; but he will be remembered longest for his wonderful machinery installed at Portsmouth Dockyard for making ships' blocks, and the then gigantic task of constructing a tunnel beneath the Thames between Rotherhithe and Wapping, a work begun in March 1825 but not completed until March 1843.

James Thomson, who for seventeen years had held the chair of mathematics at Glasgow, died on January 12, 1849, a victim to the cholera epidemic of that year. He was the father of William Thomson, the future Lord Kelvin, then professor of natural philosophy at Glasgow. The family had gone to Glasgow in 1832 from Belfast, where Kelvin was born. Thomson was not only a teacher of rare ability but also an unusually wise father, as readers of Kelvin's biography can see. Somewhat older than James Thomson was Johann Wolfgang Döbereiner, the

German chemist, who died on March 24, 1849. He was born in 1780, and in 1810 became a professor at Jena, where he discovered the property of spongy platinum which led to his patent in 1824 of the Döbereiner lamp. Another chemist who died in 1849 was George Fownes. He was then only thirty-three years old, but he had already held professorships at the Pharmaceutical Society and University College, London, had been awarded a Royal Medal by the Royal Society, and at the time of his death was secretary to the Chemical Society.

By 1849 the domains of science were rapidly being extended, and a man of science born in that year entered upon his life's work with many new fields open to him. Of the scientific events of that year, none surpassed in importance the reading to the Royal Society of Joule's paper on the "Mechanical Equivalent of Heat". Mayer, Rankine, Helmholtz, Clausius and Kelvin were all at that time deeply interested in thermodynamics, while other physicists all over the world were following the course of Faraday's long and fruitful investigations in electro-magnetism. Some of the results of all this were seen in the work of John Hopkinson (1849–98), Adolf Slaby (1849–1913), George Forbes (1849–1936), and Sir Ambrose Fleming (1849–1945), who were among the pioneers of electric power supply and of wireless telegraphy and telephony. The tragic death of John Hopkinson, who was killed in an Alpine accident with three of his children on August 27, 1898, robbed the world of a distinguished mathematician, physicist and practical engineer. Forbes, who was the son of the Edinburgh professor, J. D. Forbes, was consulting engineer in 1892 to the company formed for harnessing the water-power of Niagara Falls, and was also concerned with other hydro-electric schemes. Fleming was for forty-one years (1885–1926) professor of electrical engineering at University College, London. Adolf Slaby was a professor first at the Technical High School and then the University of Berlin, and was one of the pioneers of wireless telegraphy in Germany. The year Fleming was appointed to the chair at University College saw Raphael Meldola (1849–1915) made professor of chemistry at Finsbury Technical College, where he had as his colleagues John Perry and Silvanus Thompson. In 1921 the Maccabeans—a society mainly of Jewish professional men devoted to the promotion of the interests of the Jewish race—founded the Meldola Medal of the Royal Institute of Chemistry. Two eminent metallurgists, both Bessemer medallists of the Iron and Steel Institute, were born in 1849, namely, Johan August Brinell (died 1925), of Sweden, and Floris Osmond (died 1912), of France. The terms sorbite, martensite, troostite and austenite are due to him, and it is of interest to recall that Sorby, the virtual founder of metallurgy, began his study of thin sections of rocks by means of the microscope in the year of Osmond's birth.

Lastly, 1849 saw the birth of two well-known astronomers, William Edward Plummer (died 1928), of the Liverpool Observatory, and Matthieu-Prosper Henri (died 1903), of the Paris Observatory; and of two notable geologists, William Johnson Sollas (died 1936), who for thirty-nine years was professor of geology and palæontology in the University of Oxford, and George Mercer Dawson (died 1901), who became director of the Geological Survey of Canada and president of the Royal Society of Canada, an office first filled in 1857 by his father, Sir John William Dawson (1820–99).

OBITUARIES

Sir Wilfred Grigson, C.S.I.

Sir Wilfred Grigson's death in an air accident in Pakistan will be felt as a serious loss by the administration of that country and by anthropologists in Great Britain. He was born in 1896, the son of Canon W. S. Grigson, vicar of Polynt in Cornwall, and educated at St. John's, Leatherhead, and Christ Church, Oxford, where he held a classical scholarship. He served in Flanders, Mesopotamia and Palestine during the First World War, and entered the Indian Civil Service in 1919, starting his career in the Central Provinces, where his experiences as administrator of Bastar State turned his attention to anthropology and to the ethnology of the Gonds in particular. From Bastar he went to Berar, and in 1928 his services were lent to the Government of the Nizam of Hyderabad. He returned to the Central Provinces in 1940, but after holding several important posts there, returned to Hyderabad in 1946 as a member of the Nizam's Executive Council. Retiring from the Indian Civil Service in 1947, he entered the service of Pakistan as Commissioner for Refugees, a post in which he had to deal—and did deal with the sympathetic efficiency typical of him—with the difficult situations created by the streams of some millions of Muslims who swarmed into Pakistan from the East Punjab after the boundary commission had come to its findings.

Grigson's book on "The Maria Gonds of Bastar", published in 1938, is a model of what such a tribal monograph should be, and a review of it rightly remarked on the good fortune of the Maria "in having their affairs administered by one so wise in their ways"; while an Indian reviewer stressed his contribution "not only to the science of anthropology, but also to the art of civil administration, especially as it ought to be conducted among the less advanced castes and tribes". "He has approached", continued this reviewer, "the administrative aspects of study without bias of any kind. Whatever his political opinions he has kept them by for the moment and has dealt with the problem of the primitive tribes in a thoroughly practical and sympathetic manner."

The same might truly be said also of Grigson's report to his Government on "The Aboriginal Problem in the Central Provinces and Berar", issued in 1944, for which he took as his motto the last words of Cecil Rhodes, "so little done: so much to do", a report which fills more than 500 crown octavo pages. His last published work consists of a survey of tribal conditions in Hyderabad, and consideration of policies to be followed to improve them, in a more slender volume published at Hyderabad in 1947 under the title of "The Challenge of Backwardness". No servant of the Crown in India ever more truly earned the traditional title of 'Protector of the Poor' than Wilfred Vernon Grigson.

Dr. G. B. Grundy

George Beardoe Grundy, son of the Rev. G. B. Grundy, formerly head of Lichfield Grammar School, was born at Aspull in Lancashire in 1861. He was sent to school at Blackheath, but had to earn his living at the age of sixteen, as a teacher, first in a preparatory school, then at Wolffram's army coaching establishment; and later as head of the Cowley

Military Academy, near Oxford. In 1888 he entered Brasenose College as an undergraduate, and obtained second classes in Classical Moderations and Literæ Humaniores (1891). In the same year he married. He was already interested in Greek military history, and a geographical studentship enabled him to remain in Oxford, and also to visit the battlefields of Thermopylæ, Marathon and Platæa, where his military knowledge and skill as a field surveyor enabled him to put the study of Greek tactics on a firm basis. His account of Platæa was published by the Royal Geographical Society as a supplement to the *Geographical Journal*; other papers appeared in the *Journal of Hellenic Studies*, including a study and survey of Pylos and Sphacteria.

Grundy owed much at this period to the encouragement of Henry Pelham, who as Camden professor of ancient history was a fellow of Brasenose, and was interested in all modern developments of classical studies, and especially in archæology and geography. Grundy lectured for Pelham in 1897, and later for Brasenose College, where he was given full charge of the teaching of ancient history. For his geographical studies he received the Conington Prize in 1900, after standing *proxime* for the Arnold Prize in 1899. When the School of Geography was founded, he was appointed lecturer in ancient geography, and drew considerable classes in military and economic subjects.

In 1902 Grundy published "The Great Persian War", incorporating all his special interests in a general narrative; this was written in a lively style. Further travels in Greece led to an adventure near the north-west frontier, and to even keener interest in modern Greek politics. His historical studies were continued in "Thucydides and his Age", published in 1911, and reissued, with a second volume, in the year of his death. He travelled also in Italy, visiting especially ancient battlefields; and he had a wide interest in Roman and Saxon Britain, especially in boundaries and field names, which he hunted widely over the countryside.

In 1902 Grundy was appointed to a fellowship and tutorship of Corpus Christi College, then ruled by Thomas Case, who appreciated his vigour and originality. Here he taught continuously until 1931, taking keen interest in all aspects of college life, and also in university business. He was a champion of unpopular causes, and a vigorous speaker in Congregation, but took no part in administration. An all-round athlete until middle life, he became later an expert croquet player. He was a frequent contributor of light verse to the *Oxford Magazine*, translated selections from the "Greek Anthology", and in 1945 published an 'unconventional biography', the record of his "Fifty-Five Years at Oxford".

JOHN L. MYRES

WE regret to announce the following deaths:

Mr. Frank Nasmith, a founder member and president during 1938–39 of the Textile Institute, on November 16.

Dr. M. C. Rayner (Mrs. W. Neilson Jones), formerly head of the Department of Botany, University College, Reading, known for her work in forestry research, on December 17.

Dr. G. Scott Robertson, permanent secretary of the Ministry of Agriculture, Northern Ireland, and formerly professor of agricultural chemistry in Queen's University, Belfast, aged fifty-three.

NEWS and VIEWS

East Malling Research Station: Dr. R. G. Hatton, C.B.E., F.R.S.

THE many friends and scientific colleagues of Dr. R. G. Hatton will learn with regret of his resignation from the directorship of the East Malling Research Station for reasons of ill-health. For some years he has been far from well and, though advised medically to take things more easily, Hatton is not the man to let up on his work if he is physically capable of getting to his office. Born in 1886, he is a Balliol man who, after graduating, decided his interests lay in agriculture and horticulture; and he went to Wye College, later becoming acting-director during the First World War of what was then the College's Fruit Experimental Station at East Malling. When it became an independent research station in 1918, Hatton was its first director, and it is to his personal energy, vision and administrative ability that the Station owes its present position as one of the foremost horticultural research centres of the world. His own work on the sorting-out and classification of fruit-tree rootstocks would alone justify his high position in science and his fame among fruit-growers in all countries. Apart from his many scientific writings, Hatton, in his early years, made one excursion into general literature. His delightful "Folk of the Furrow" was published in 1913 under the pen name of "Christopher Holdenby", and it was many years before even his closest friends knew that he was the author.

The National Physical Laboratory, Physics Division: Dr. B. W. Robinson

DR. BERNARD WHEELER ROBINSON was appointed in October 1948 as superintendent of the Physics Division, National Physical Laboratory, in succession to Mr. W. F. Higgins. Dr. Robinson was born in 1904. He studied mathematics and physics at Trinity College, Cambridge, and then spent two years at the Cavendish Laboratory under Lord Rutherford. Afterwards, as research assistant to Sir William Bragg at the Davy Faraday Laboratory, Royal Institution, he specialized in instrument design and the technique of X-ray crystallography. He later held the post of senior lecturer in physics at the Military College of Science. During the Second World War, Dr. Robinson was associated with the development of gunsight and fire-control instruments for aircraft, including the 'gyro-gunsight'. He was later concerned with work on the remote control of aircraft guns, a project closely related to the extensive wartime advances in the field of servomechanisms. Finally, under the Directorate of Armament Development, Ministry of Aircraft Production, he was in general charge of fire-control research. After the War, Dr. Robinson was engaged on specialized instrument work for the National Institute of Medical Research, translating the requirements of the physiologist and biochemist into the design of new physical instruments.

Electrical Engineering at Dundee : Prof. E. G. Cullwick

Dr. E. G. Cullwick, at present director of electrical research of the Defence Research Board, Ottawa, has been appointed to the newly instituted Watson-Watt professorship of electrical engineering at University College, Dundee. A native of Wolverhampton, Prof. Cullwick took the Mechanical Sciences Tripos at Cambridge, and after a subsequent period in industry with the British Thomson-Houston Co., Ltd., Rugby, and the Canadian General Electric Company, joined the staff of the Electrical Engineering Department of the University of British Colombia. He became head of this Department in 1937, but from 1942 served with the Royal Canadian Navy as director of electrical engineering. His return to academic work, and particularly to Great Britain, will give much satisfaction to those to whom his contributions to the teaching of electromagnetism have proved so helpful.

Cacao Disease in the Gold Coast

The Commission on Swollen Shoot Disease of Cacao (see *Nature* of October 30, p. 689) arrived in the Gold Coast at the end of October and left Accra on December 5. On December 3, it held a Press conference in Accra and the following statement was issued: "The Swollen Shoot Commission has now been at work for about six weeks. During that time it has examined a vast mass of evidence and has heard from representatives of all the groups of people concerned—farmers, scientists at the West African Cacao Research Institute, survey officers, and agricultural officers. . . . The undisputed fact is that swollen shoot is a contagious disease of the virus type. Drought, Akate, old age, lack of canopy and poor soils have nothing whatsoever to do with it. The virus causing this disease is present in all parts of a diseased tree, and once it has established itself it cannot be eliminated except by the destruction of the tree in which it lives. How then does a tree become infected? There is only one way in Nature whereby this can be done and that is by the feeding of an *infected* mealybug on a healthy tree. Not all mealybugs, of course, are infected. They can become infected *only by feeding* on a diseased tree, and before they can infect another tree they must move from the diseased tree to a healthy one. How then can such a disease be controlled? With this type of virus disease, the basic method of control is to remove all possible sources of infection. In the case of swollen shoot this means diseased cocoa trees, and in addition, certain wild forest trees which are known to carry swollen shoot infection, this being the only way in which healthy trees can be protected from infection. The Commission will include in its final report a discussion of means which may be of some use for the sanitation and rehabilitation of cocoa in the future, but it is certain that these measures can only be additional to the cutting out. . . . The Commission's gravest concern is with the cutting out programme itself. We have to stress that even this method can save the cocoa culture only if it is done accurately, thoroughly and continuously, and without delay. . . . The Commission has spent a long time at the Research Institute at Tafo and has studied very thoroughly all their investigations. We have a great appreciation for the splendid work being done and we strongly advise the cocoa farmers to have confidence in these scientists, who are working solely in the interests of the cocoa farmers of the Gold Coast.—G. H. Berkeley, Walter Carter, E. Van Slogteren."

International Institute of the Hylean Amazon

Unesco's Hylean Amazon Project, since its inception two years ago, has been sustained by world-wide interest which reached its climax when delegates of interested nations agreed at Iquitos, Peru, last May that the International Institute of the Hylean Amazon should be established. Extending from the Andes to the Atlantic and from the River Orinoco to the Mountains of Bolivia, the Hylean Amazon—the vast wooded region of the Amazon River basin—is some seven million square kilometres in area. Except for a few towns and settlements, mainly along the river banks, the only inhabitants of this region are about three hundred thousand Indians, whose conditions of life in many cases are extremely primitive. The density of population of the region is one of the lowest in the world. The new Institute will study the problems of botany, zoology, physiography, agriculture, social sciences and education in relation to that area. The project for the creation of an international research institute in the Hylean Amazon has been inspired by the past history of the region. Since the discovery of Amazonia, it has been explored by scientific missions of many nationalities with the aim of drawing up its botanical and zoological inventory, of becoming acquainted with the state of social development and organisation of its native tribes, of determining the essential characteristics of its climate and soil, of carrying out archæological excavations and finally of opening up the economic wealth and exploring the demographic possibilities of its vast area.

These long and difficult tasks have too often remained fruitless for want of a permanent centre or body to co-ordinate them, follow them up and pass them on to succeeding generations. Furthermore, the materials collected by various expeditions were often lost, and their reports, although still extremely valuable documents, are largely scattered and forgotten. One of the primary tasks of the Institute is to bring to life all that exists in archives, libraries and museums concerning Amazonia, and further to renew, with continuity and greater resources, the admirable efforts of the past. In addition to the seat of the Institute at Manaus, it is planned to establish research centres at the following places as soon as possible: Archidona (Ecuador), Belem do Para (Brazil), Iquitos (Peru), Riberalta (Bolivia), San Fernando de Atabapo (Venezuela) and Sibundoy (Colombia). It has been realized that it is not possible to project into the distant future a research programme for the Institute, except in broad outlines. Of immediate concern is the definition of the Institute's programme for its first year of operation, for which a budget of approximately 300,000 dollars has been provided.

Child Development Study in London

It has long been felt by those concerned either with the health or with the education of children that a close study of growth and development, both physical and psychological, conducted on the same group of children in a parallel series of observations, would yield valuable basic material. In 1947, Dr. D. H. Geffen, medical officer of health of St. Pancras, and Prof. Alan Moncrieff, of the Institute of Child Health, University of London, placed before the governors of

the Foundling Hospital in London a scheme for utilizing their residential nursery, day nursery and nursery school at Coram Gardens for teaching and research purposes. It was also suggested that a maternity and child welfare centre might be started on the same site. The next development arose when the Central Council for Training in Child Care, concerned with the training of boarding-out officers and house mothers under the Children's Act, found a shortage of seniors who could take up posts of a supervisory character or as tutors in the various education schemes. The Institute of Education of the University of London and the Institute of Child Health therefore decided to put forward a plan for a joint training and research centre at the Foundling Hospital site. This was discussed with representatives of the Home Office, of the Ministry of Health and of the London County Council Public Health and Education Departments. Eventually a scheme was agreed, under which the financing of the teaching side would be undertaken by the Institute of Education and that of the research side shared between this Institute and the Institute of Child Health with the approval of the University of London authorities.

On the training side the first course will begin immediately. Provision has been made for the appointment of a senior tutor and a junior tutor and for visiting lecturers. Dr. Agatha Bowley has been appointed senior lecturer in child care and Miss J. E. Cass as tutor in child care. Members of the teaching staff of both Institutes will take part in the course. Miss Cass has also been appointed honorary educational supervisor to the day nursery on the Foundling Hospital site, so that there may be general co-operation with the staff in relation to the training of probationers for the National Nursery Certificate. On the research side, provision has been made for two educational research assistants, for a part-time medical assistant and for part-time assistance from the Child Guidance Clinic at the Hospital for Sick Children, Great Ormond Street. Plans for a pilot survey are well advanced. In addition to detailed observations on children in the nurseries and nursery schools, it is planned to extend the investigation to babies in the same area who are not attending such institutions. In this way one of the objects of the research programme is to attempt to assess the educational values or disadvantages of the nursery or nursery school. Those concerned with the planning are endeavouring to take a long view, hoping to follow children through the nursery school to the primary school period and even eventually to adolescence in the youth centre activities in the Harmsworth Memorial Playground, also on the site of the original Foundling Hospital.

Effect of the Severe Winter of 1946–47 on Bird Life

N. F. Ticehurst and P. H. T. Hartley (*British Birds*, **41**, No. 11; November 1948) have examined 121 reports on the effects of the hard weather of early 1947 on bird life. February 1947 was the coldest month in Britain since 1895, and, in some parts of the country, temperatures were lower than any noted since records were begun in 1815. Many species of birds were greatly reduced in numbers; but one of the striking features of the collated reports is the lack of any consistency in the proportionate reduction of numbers of groups of allied or ecologically similar species. For example, in the Wirral peninsula tree-creepers were scarcely affected, though nuthatches were much reduced; but on the Surrey–Sussex border tree-creepers suffered heavily and nuthatches not at all. In south-west Devon and in Cardigan, blackbirds suffered heavier reduction than song-thrushes; in the rest of the country blackbirds fared much better than song-thrushes. The diminutions of the stocks of the various species over the country as a whole shows few consistent trends, and probably the only general statements which can be made are that some specimens of most of the winter residents of Britain were found dead, there were relatively few reports of icing of plumage or feet—a cause of mortality frequently recorded in 1939–40—and that there were many reports of unusual shifts of birds in search of food.

Bulletin of the Botanical Society of Bengal

At the hands of scholars of the new Dominion, Indian botany may fairly be said to be on its way and making good progress on a wide front. This is apparent from a survey of the contents of recent journals. The second volume of the new *Bulletin of the Botanical Society of Bengal* (April 1948) contains papers on cytology, genetics, comparative and developmental morphology, mycology and physiology. Thus the aim of the *Bulletin*, to publish original researches, is being fulfilled. This aim is in no sense marred by the fact that in this, as in other Indian botanical journals, plants of economic importance are often selected for special study; on the contrary, the indigenous and introduced crops, in their many aspects, afford materials of remarkable interest for the investigator; for example, mangoes and bananas among tropical fruits, rice among cereals, and jute among textiles. Papers relating to these crops appear in the current number, while a review of the Bignoniaceæ of India and Burma serves to remind us of the floristic wealth of this great sub-continent.

Advisory Committee on Medical Nomenclature and Statistics

The Registrar General announces that his Advisory Committee on Medical Nomenclature and Statistics, the function of which is to consider from the medical point of view and to advise upon questions affecting the International Statistical Classification of Diseases, Injuries and Causes of Death, and any other matters concerning medical nomenclature or statistics which may be referred to the Committee, is constituted as follows: Sir Ernest Rock Carling (chairman); Sir Allen Daley, chairman of the Council of the Society of Medical Officers of Health; medical officer of health and school medical officer, London County Council; Prof. Ernest Finch, emeritus professor of surgery, University of Sheffield; Dr. F. H. K. Green, assistant secretary, Medical Research Council; Dr. C. F. Harris, dean of the Medical College, St. Bartholomew's Hospital; Prof. A. Bradford Hill, professor of medical statistics, University of London; Prof. A. J. Lewis, professor of psychiatry, University of London; Dr. A. Massey, chief medical officer, Ministry of National Insurance; Dr. P. L. McKinlay, superintendent of statistics, General Registry Office, Edinburgh; Prof. N. C. W. Nixon, professor of obstetrics and gynæcology, University of London; Dr. W. N. Pickles, medical officer of health, Aysgarth, Yorkshire; Dr. A. H. T. Robb-Smith, Nuffield reader in pathology, University of Oxford; Dr. Percy Stocks, chief medical statistician, General Register Office; Prof. R. E. Tunbridge, professor of medicine, University of Leeds; Sir Lionel Whitby, regius professor of physic, Department of Medicine, Univ-

ersity of Cambridge ; Miss A. L. Winner, medical officer, Ministry of Health. The secretary of the Committee is Mr. L. M. Feery, General Register Office, Somerset House, London, W.C.2.

Seventh Pacific Science Congress : Royal Society Delegates

THE Royal Society has appointed a delegation of six of its Fellows to attend the Seventh Pacific Science Congress to be held at Auckland and Christchurch, New Zealand, during February 2–22. The programme of the Congress will provide for contributions and discussions on scientific topics of special significance to the Pacific area, and of importance for the welfare of Pacific peoples. Problems depending for their solution on co-operative studies by two or more sciences will be presented for discussion in symposia. Public lectures will be given, and local excursions will be made to places of scientific interest near Auckland and Christchurch. The delegates are : Dr. G. E. R. Deacon, of the "Discovery" Committee, Colonial Office, and the Royal Naval Scientific Service (also representing the Admiralty); Sir Norman Haworth, professor of chemistry and director of the Department of Chemistry in the University of Birmingham since 1925 until retiring last October ; Prof. H. D. Kay, research professor of biochemistry, University of Reading, and director, National Institute for Research in Dairying, University of Reading ; Prof. G. W. Robinson, professor of agricultural chemistry, University College of North Wales, Bangor ; Sir Geoffrey Taylor, Yarrow research professor of the Royal Society ; Prof. C. M. Yonge, regius professor of zoology, University of Glasgow. At the invitation of the Vice-Chancellor of the Australian National University, Canberra, Sir Norman Haworth and Sir Geoffrey Taylor will spend some time in Australia visiting university laboratories before they return to Great Britain.

University Grants Committee

THE term of office of a number of members of the University Grants Committee is about to expire and the committee has been reconstituted with the following membership : Sir Walter Moberly (chairman), Dr. A. E. Trueman (deputy chairman), Prof. E. D. Adrian, Sir Charles Darwin, Miss D. Dymond, Mr. H. L. Elvin, Mr. E. James, Mr. H. S. Magnay, Prof. W. R. Niblett, Prof. P. S. Noble, Prof. D. Hughes Parry, Prof. G. W. Pickering, Prof. E. K. Rideal, Prof. H. G. Sanders, Prof. J. C. Spence, Sir Alexander Murray Stephen, Mr. B. H. Sumner and Miss Barbara Wootton.

University of Leeds

THE following appointments have been made in the University of Leeds : Dr. R. D. Preston (senior lecturer in botany), as reader in plant biophysics ; Dr. R. Brown (senior lecturer in plant biochemistry), as reader in plant physiology ; Dr. T. D. Day, as senior research fellow in experimental pathology and cancer research ; Mr. G. C. Easty, as Brotherton research fellow in physical chemistry in the Department of Colour Chemistry.

The University has recently received the following gifts, among others : two research scholarships, each of the value of £325 a year, plus an allowance of £50 for apparatus, from the Coal Tar Research Association ; from Imperial Chemical Industries, Ltd., £200 towards the cost of equipping a laboratory in the Colour Chemistry and Dyeing Department, £200 for research in the Department of Biomolecular Structure, and explosives and detonators for the Mining Department ; an electric gyroscope presented to the Mathematics Department by the Sperry Gyroscope Co., Ltd.

The Night Sky in January

FULL moon occurs on Jan. 14d. 21h. 59m., U.T., and new moon on Jan. 29d. 02h. 42m. The following conjunctions with the moon take place : Jan. 17d. 15h., Saturn 3° S. ; Jan. 27d. 06h., Jupiter 5° N. ; Jan. 27d. 08h., Venus 5° N. In addition to these conjunctions with the moon, the following conjunctions with planets occur : Jan. 7d. 18h., Mercury in conjunction with Mars, Mercury 0·8° S. ; Jan. 26d. 08h., Venus in conjunction with Jupiter, Venus 0·02° S. ; Jan. 27d. 21h., Mercury in conjunction with Mars, Mercury 3·6° N. Mercury attains its greatest easterly elongation on Jan. 18 and sets at 16h. 40m., 17h. 52m. and 17h. 23m. on Jan. 1, 15, and 31 respectively, and can be seen for a short time as an evening star. Venus rises at 6h. 15m., 6h. 42m. and 6h. 57m. at the beginning, middle and end of the month respectively, and can be seen shortly before sunrise as a morning star. Mars sets more than an hour after the sun, but is still too close to the sun for favourable observation. Jupiter is in conjunction with the sun on Jan. 1 and rises an hour before sunrise at the end of the month, but is still too close to the sun to be favourably observed. Saturn rises at 20h. 56m., 20h. and 18h. 50m. on Jan. 1, 15 and 31 respectively, stellar magnitude 0·8–0·5, and can be observed throughout the night in the constellation of Leo. Occultations of stars brighter than magnitude 6 are as follow : Jan. 10d. 22h. 54·2m., 133 *B.* Taur. (*D*) ; Jan. 11d. 02h. 17·3m., 32 Taur. (*D*) ; Jan. 12d. 17h. 40·7m., 112 *B.* Auri. (*D*) ; *D* refers to disappearance and the latitude of Greenwich is assumed. The earth reaches perihelion on Jan. 3d., when its distance from the sun is about 91,450,000 miles.

Announcements

PROF. P. DANGEARD, of the University of Bordeaux, and M. Louis Emberger have been elected *correspondants* for the Section of Botany of the Paris Academy of Sciences, in succession to the late MM. Emile de Wildeman and Ernest Pinoy.

MR. ROBERT BARER, of the Department of Human Anatomy, Oxford, has been appointed Alan Johnston, Lawrence and Moseley Research Fellow of the Royal Society for two years from January 1, 1949, renewable for a further three years. He will continue his work at Oxford on the biological and medical applications of new methods of microscopy, with special reference to the Burch reflecting microscope.

DR. MAGNUS PYKE, who since the spring of 1946 has been principal scientific officer responsible for nutrition in the Ministry of Food, has been appointed to the research staff of the Distillers Company, Ltd., as deputy manager of the Company's new Yeast Research Outstation at Glenochil, Clackmannanshire.

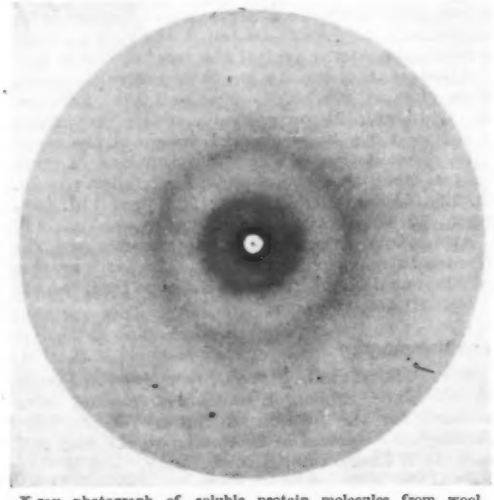
MR. H. G. FOSTER, lecturer in the Department of Electrical Engineering, University of Birmingham, has been appointed editor of *Electronic Engineering*, in succession to Mr. G. Parr, who has become technical director of Messrs. Chapman and Hall, Ltd., publishers.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Regenerated Keratin Fibres

In the past few years considerable progress has been made in the regeneration of certain protein fibres from solution; in particular, casein[1] and peanut globulin[2] have been spun with considerable success. Hewitt and Coleman[3] have dissolved and respun silk, Lundgren[4] and his co-workers have made fibres from dissolved chicken feathers, and one of us (R. L. W.) has described the regeneration of a protein from a mixture of casein and soluble keratin[5]. In the following, a short description is given of the regeneration of wool keratin fibres from solution. This material was made by the method previously described by Wormell[5], and its X-ray photograph is reproduced herewith. It can be seen from this diagram that the keratin molecule is in the β or fully extended form, and there is no evidence of the presence of the typical α-fold of the original wool molecule.



X-ray photograph of soluble protein molecules from wool, showing a typical denatured β-keratin structure. Copper $K\alpha$ radiation. $D = 3$ cm.

The soluble keratin curd was dissolved in dilute cuprammonium solution, centrifuged and precipitated with sulphuric acid. The curd was then washed in water, redissolved in cuprammonium solution, and after further centrifuging, the solution was spun, as previously described for the casein/keratin mixtures[5], into a saturated solution of sodium sulphate (pH = 7) containing 0·1 per cent 'Fixanol'. Finally, the resulting fibres were hardened in a bath of sodium sulphate and formaldehyde, and insolubilized in a solution of sulphuric acid, sodium sulphate and formaldehyde at approximately 50° C.

An X-ray study of the resulting fibres showed that they had retained the β-keratin structure. Traces of orientation could be detected, but there was a definite decrease in the crystallinity of the protein at this stage. In particular, the definition of the 4·65 A. backbone spacing was not so good in the fibre as in the original protein curd. It was found, however, that the fibres could be readily stretched in hot water or steam to extensions greater than 100 per cent of their original length. The X-ray diagram of a fibre so stretched showed a redevelopment of a crystalline β-keratin structure, with a reasonably good orientation of the molecules along the fibre axis.

From the above experiments, it is clear that the dissolution and extrusion of wool can readily be carried out after the cystine cross-links have been broken down by swelling and dispersion of the protein in aqueous sodium sulphide. The long-chain keratin molecules remain in solution without extensive degradation; the specific α-configuration of the molecule is apparently destroyed, and the resulting protein is capable of reformation from a dispersion in cuprammonium hydroxide into fibres showing the crystalline β-form. Hardening and insolubilizing processes can then be applied to the material to produce a regenerated protein fibre in a manner somewhat similar to that used in casein fibre manufacture.

Note added in proof.—Since this note was submitted for publication, regenerated keratin fibres have been made with an average tenacity of 0·8 gm./denier and 30 per cent extension at break, measured at 65 per cent relative humidity and 70° F. From this point of view at least, the fibres can be considered as being in the range of usable textile materials.

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Nov. 16.

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[3] Hewitt and Coleman, *Proc. Roy. Soc.*, A, **190**, 145 (1947).
[4] Ward, High and Lundgren, *J. Polymer Res.*, **1**, 22 (1948).
[5] Wormell, *J. Tex. Inst.*, **39**, P.T. 219 (1948).

The elastic properties of the keratin fibres, wool and hair, have been shown to result from a folded molecular structure capable of reversible extensibility[1]. This folded structure gives rise to a large-angle X-ray pattern, referred to as the α-pattern, which characterizes an extensive class of proteins, the α-proteins[2]. In view of the dependence of the elastic properties of the keratins on the α-structure, it is a desirable goal in the preparation of artificial fibres to obtain a regenerated protein from suitable raw materials possessing this structure.

Most regenerated proteins when sufficiently oriented in the fibrous form yield the β-type X-ray pattern, indicating the presence of straight rather than folded chains[3,4]. It has been found possible, however, by using stronger solutions of the type employed by Lundgren and colleagues[3] (saturated urea containing reducing agents) to dissolve a substantial fraction of a 'hard' keratin such as wool. The dissolved protein may be readily salted out of solution. Two kinds of precipitated protein have been prepared: (*a*) a non-orientable material, obtained at pH 6–7 and temperature 40° C., with properties resembling those of chewing-gum; and (*b*) an orientable fibrous form at pH 8–9 and 50° C. The first material may be drawn into threads, but these are non-birefringent and yield an X-ray pattern consisting only of two diffuse rings. The second may be drawn into fine fibres with anisotropic physical properties, marked birefringence and yielding the α-type X-ray pattern. It strongly resembles Rudall's 'epidermin'[5] prepared by extract-

ing the germinal layer of skin with strong urea, and the method of preparation is in a sense a reversal of the process of keratinization. The fibres can be hardened by formaldehyde.

A preliminary examination of the dissolved keratin by means of the ultracentrifuge, carried out in collaboration with the Swedish Textile Research Institute, Göteborg, shows that it is poly-disperse but possesses a substantially greater molecular weight than the solutions obtained using reducing agents at high *p*H, such as sodium sulphide.

During the treatment of wool with the urea reducer solutions the fibre form is preserved, but a contraction in length occurs of the order of 30 per cent. Examination by X-rays of such wool after re-extension shows that the protein is now in the 'cross β-configuration', that is, the strong spacing at 4·65 A. normally found on the equator of the X-ray photograph now occurs on the meridian. The 'cross β' pattern appears to arise from crystallites which are longest in the backbone direction at right angles to that of the main chains, and illustrates a further possibility of protein-chain folding. It has been obtained from denatured egg white[6], epidermin[5] and in some preparations of Palmer and Galvin[7], but has not previously been reported from wool, the typical α-protein.

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Some Effects of the Helical Fibrillar Structure of Vegetable Fibres

In jute, the fibrils in the cell-wall are arranged in right-handed helices, that is, they show the *Z* twist of textile workers, and the drying-twist is counter-clockwise. In flax, with the fibrils in left-handed (or *S*) helices, the drying-twist is clockwise[1]. So far as we know, the following results are the first of their kind to be reported, and although they were obtained with bundles of jute fibre-strands, similar relationships must also hold for jute yarns. Tests were made in a room conditioned to about 75 per cent relative humidity, and the test-pieces were carefully sampled out.

Insertion of *Z* twist into the bundles increases the twist of the fibrils in the cell-walls, and this seems adequate to explain the lower breaking-twist and higher torsional rigidity observed with *Z* twist. The smaller diameter of the bundles under *Z* twist is presumably partly due to the same effect; but it is probable also that the insertion of *S* twist buckles the strands slightly, giving poorer packing.

The effect of direction of twist on bundle strength is not so readily interpreted. When the breaking load of the bundle is approached, the strands are under considerable tension, and buckling under a moderate *S* twist may then be absent. We may suppose that, with *S* twist, some untwisting of the fibrils, while they are under high tension, increases the tensile strength of the cells; the slight twisting-up of the fibrils that follows drying-out after retting is counteracted, and their arrangement becomes closer to that which obtained in the growing plant than it does under *Z* twist, where the twist of the fibrils is further increased.

Jute spinners use *Z* twist for ordinary yarns. Ease of spinning, yarn strength and yarn compactness are concerned, and which twist is the better may depend on the use to which the yarn is to be put. A full account of the work will be given elsewhere.

Breaking-twist. Bundles of fibre-strands of standard weight and length (0·4 gm., 10 in.) were made up from hand-combed jute. The breaking-twist of each bundle was determined as follows. The upper end was gripped in a ro. able clamp, while to the lower end a weight (1 kgm., was attached, the weight being prevented from rotating, but free to rise as the twist was inserted. The upper clamp was rotated, clockwise or counter-clockwise, until the bundle broke. The initial distance between clamps was 9 in.

The mean breaking-twists for thirty samples of white jute (*C. capularis*), varying widely in quality, are given below as turns per inch, based on the initial 9-in. test-length. Thirty bundles from each sample were used for each direction of twist, making a total of 1,800 bundles.

Mean breaking-twist (turns per in.)		Difference and standard error
S twist	*Z* twist	
4·14	4·05	0·09 ± 0·015

Bundle diameter. Measurements were made, on the same thirty samples of jute, by an optical projection method. The twist inserted (1·44 turns per in.) was much less than the breaking-twist and approximated to that which would give maximum strength in a yarn.

Mean bundle-diameter (mm.)		Difference and standard error
S twist	*Z* twist	
1·78	1·76	0·02 ± 0·004

The difference, though small, is highly significant.

Breaking-load. The measurements were made on standard bundles with a standard twist, comparable to that which would give maximum strength in a yarn. Triplicate tests on two qualities of jute gave the following results, each being the mean of ten. Again the differences are highly significant.

	Sample *A* Breaking-load (lb.)		Sample *B* Breaking-load (lb.)	
	S	*Z*	*S*	*Z*
	388	369	236	229
	396	377	217	212
	401	369	253	245
Means:	395	372	235	229

Torsional rigidity. This was measured by noting the period of oscillation (*t* sec.) of a metal disk suspended horizontally from the lower end of the bundle. Two qualities of jute gave the following results in triplicate tests, each being the mean for ten bundles. Under *S* we give the results when the disk was initially turned in the direction that inserted *S* twist into the bundle, before releasing it for timing. The differences are less significant here, but the trend

	Sample *C* Torsional rigidity		Sample *D* Torsional rigidity	
	S	*Z*	*S*	*Z*
	19·5	19·6	21·1	22·4
	20·0	20·6	21·1	21·2
	19·1	19·3	20·5	20·1
Means:	19·6	19·8	20·9	21·2

seems clear, and is supported by other available data. The values given are $10^4/t^3$, and are proportional to the torsional rigidity of the bundles.

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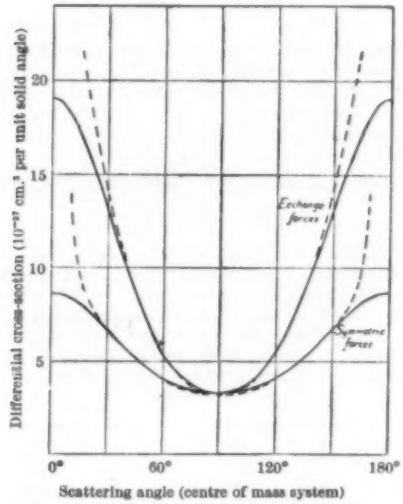
Scattering of Like Particles at 100 MeV.

Previous calculations[1] of the cross-sections for neutron–proton scattering at 100 MeV. have been extended to the case of scattering of like particles. Assuming the forces are independent of the charge, the constants of the exponential potential $V \exp(-r/a)$ can be obtained from the deuteron problem. For $a = 0{\cdot}5 \times 10^{-13}$ cm. the values of V were found to be 191·2 MeV. in the even singlet states for both exchange and symmetric forces, and 313·5, 104·5 MeV. in the odd triplet states for exchange and symmetric forces respectively. (These states are the only ones that occur for like particles.) The cross-sections for proton–proton scattering were obtained by modifying the neutron–neutron calculations to allow for the Coulomb interaction.



Full lines, neutron–neutron scattering; broken lines, proton–proton scattering

The differential cross-sections in the centre of mass system are shown in the diagram (both incident and scattered particles are counted). As for the neutron–proton case, the difference between the scattering for exchange and for symmetric forces is marked only at extreme angles; here, however, the former is always the greater, so that the total cross-section for exchange forces is significantly larger than that for symmetric forces. The total cross-sections, including for comparison those for neutron–proton scattering, are:

	Exchange force	Symmetric force
Neutron–neutron	$9{\cdot}1 \times 10^{-26}$ cm.^{2}	$5{\cdot}9 \times 10^{-26}$ cm.^{2}
Neutron–proton	$8{\cdot}7 \times 10^{-26}$ cm.^{2}	$8{\cdot}8 \times 10^{-26}$ cm.^{2}

Ashkin and Wu[2] have calculated the ratio of neutron–proton to neutron–neutron cross-sections in the Born approximation in the limit of very high energy. For the energy and potential used here, the Born approximation gives the ratio 1·0, 2·6 for exchange and symmetric forces respectively, compared with 1·0, 1·5 obtained from the exact calculation. Thus great care must be taken in using the results of the Born approximation at these energies.

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[2] Ashkin and Wu, *Phys. Rev.*, **73**, 973 (1948).

Measurements of α-Particle Energies with the Crystal Fluorescence Counter

Measurements of low α-particle intensities are usually carried out by counting ionization impulses produced either in Geiger counters or in ionization chambers connected to an amplifier. The latter method has the advantage of allowing a rough evaluation of the energy of the particles, as the number of ions produced in the chamber is accurately proportional to the energy of the ionizing particle, needing 32 volts for the production of one pair of ions in air. This method has the drawback that it needs rather high amplification.

We have developed a new method of measuring single particles by counting the impulses of light quanta produced in fluorescent substances, different for different sorts of radiation (α-, β- and γ-radiation)[1]. This method has the advantage that it needs only low amplification, and that the reacting material need not be enclosed in a vacuum tube but is easily accessible from all sides. Hitherto no quantitative energy measurements have been accomplished by this method. For such investigations two questions have to be solved: How does the yield of light depend on the energy of the energizing particle, and what is the shape of the impulse-intensity distribution curve for particles of equal energy? In other words, do particles of the same energy give rise always to impulses of equal intensity? As a matter of fact, this is not so with the powdered fluorescent substances generally used, due to the large light-scattering taking place in these materials. We have overcome this difficulty by employing large single fluorescent crystals of cadmium sulphide, which are especially suitable for such measurements, due to their high transparency for light. These crystals are prepared in our laboratory by R. Warminsky according to a method of R. Frerichs[2]. By appropriate treatment of these crystals we have obtained a brilliant red fluorescence on excitation with α-particles. The energy-yield of cadmium sulphide is comparable to that of the best zinc sulphide.

With these crystals we have carried out the following experiments. In a vacuum tube just above the window of a photo-multiplier we placed a crystal of several square centimetres surface area about 4 cm. away from a polonium α-particle source. By altering the pressure in the tube we could vary the energy of the α-particles impinging on the crystal from zero

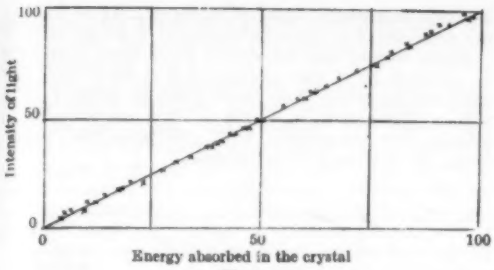

Fig. 1

energy up to 5 million volts. The number of the incident particles was kept constant throughout the whole operation, being controlled by additional measurements. With this arrangement the output of light was measured as a function of the energy of the energizing particles. The results are given in Fig. 1, which shows that over the whole range of energy the intensity of light is proportional to the energy absorbed in the crystal. The arrangement was sensitive enough to allow the measuring of an α-particle current of 100 particles per second. All thicknesses of crystals up to 200 mgm. per sq. cm. are now available; these experiments were carried out with a crystal of about 10 mgm. per sq. cm.

We then placed the crystal directly on the window of the multiplier and covered it with a mirror, through a hole in which nearly mono-energetic α-particles impinged on the crystal. The mirror reflects all the light emitted into the multiplier. Thus the intensity as well as the homogeneity of the light impulses are considerably increased, since the light comes only partly from the head surfaces of the crystal, but is preferably emitted through its small edge-faces due to total reflexion in the crystal. The number of impulses were then counted by an ordinary thyratron counter in connexion with a linear amplifier as a function of the thyratron grid potential. The curve thus obtained was differentiated and gives then the number of impulses as a function of the intensity of the light flashes. This curve (Fig. 2) has a sharp maximum at a definite intensity which corresponds to the energy of the homogeneous α-particles' energy. It shows that about 80 per cent of all impulses have the same intensity; only at its base is the curve somewhat broader. This broadening is partly due to the incomplete homogeneity of the energy of our α-source. How large the small remaining real inhomogeneity of the light impulses themselves is, is not yet established.

Finally, we have measured the absolute yield of light of our crystals[3]. The spectrum of the emitted light has its maximum near 8,000 A. That means a medium energy of the light quanta of 1·7 electron volts. We found that the best crystals need 7·7 electron volts to produce one light quantum.

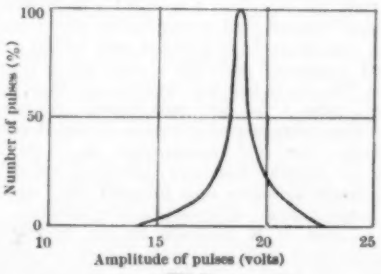

Fig. 2

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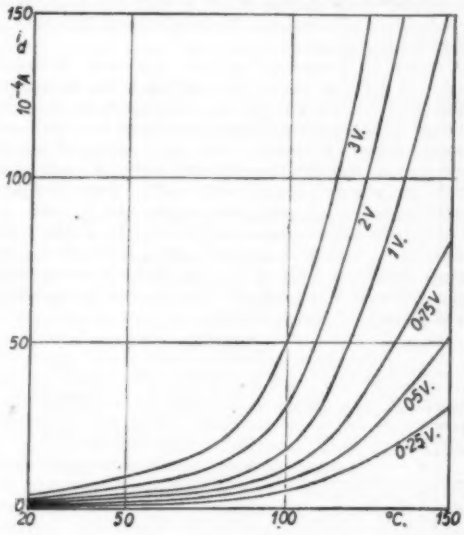
New Method for the Measurement of the Thickness of the Barrier Layer in Rectifiers

The thickness h of the barrier layer in the barrier-layer rectifiers has been deduced from electrical capacity measurements by several authors. Schottky and Waibel (1932) gave the value 10^{-5}–10^{-4} cm.; Dowling and Place, $\approx 10^{-4}$ cm. More recently, Waibel (1936) gives values as high as 10^{-3} cm. With such high values of h, Mott's theory gives the true direction of rectification.

The value of h can be obtained by a very simple and direct new method on the following principle. The dependence of the intensity i_d of the electric current produced by a tension V in the forbidden direction is a function of the temperature as in the accompanying graph (copper oxide rectifier, active surface $\approx 0{\cdot}80$ cm.^{2}, $V = 0{\cdot}25$–3 V.).



The measurements must be made by a ballistic method because the current i_d itself increases the temperature of the rectifier. If the applied tension V is not instantaneous but lasts for some time t, we observe, indeed, a value of i_d increasing with time. It is natural to ascribe the growth of i_d to the increase of the barrier layer temperature by the Joule effect $i_d.V.t$, the drop V of the tension being almost completely localized in this layer. The accompanying graph gives the rise of temperature of the layer dur-

ing a time t deduced from the observed rise of i_d. We assume that this barrier layer is a film of cuprous oxide. From the specific heat and the specific mass of cuprous oxide, and from the area of the barrier layer, we get its thickness h.

In this way we find a value for h of $(2{\cdot}0\text{–}4{\cdot}1) \times 10^{-4}$ cm. (Westinghouse copper oxide rectifiers); that is, rather less than the Waibel value of 1936.

An extensive research on the dependence of h upon several physical variables is now in progress.

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Tensor Forces and the Neutron–Proton Interaction

In a recent article, "On the Neutron–Proton Force"[1], Blatt has advanced cogent evidence for an "effective triplet range" of between $1{\cdot}30$ and $1{\cdot}55 \times 10^{-13}$ cm., that is, for a triplet range which would correspond to a square-well-width of between $1{\cdot}5$ and $1{\cdot}7 \times 10^{-13}$ cm. In view of the new importance given to investigations using well-widths of these magnitudes, the preliminary results of some calculations on the binding energy, quadrupole moment and magnetic moment of the deuteron may be of interest.

The work closely follows the classical calculations of Rarita and Schwinger[2], except that the ordinary and tensor force ranges are not assumed to be equal, and neither is restricted to $2{\cdot}8 \times 10^{-13}$ cm.; and that the labour of solution has been lightened by use of a differential analyser.

A paper by Guindon has just appeared[3] in which results of similar work for central force ranges of $2{\cdot}5\text{–}3 \times 10^{-13}$ cm. are given. His notation will be adhered to in this note. Four parameters are involved, namely, range of central force (r_0), range of tensor force (εr_0), depth of (square) central well (J), depth of (square) tensor well (γJ). Thus, for any chosen value of r_0 we may expect to be able to satisfy three independent conditions. In Table 1 the values of r_0, J and γJ are such that, for each r_0, the correct binding energy E and quadrupole moment Q, and a value of 4 per cent for the D-state probability, are obtained for the deuteron.

Table 1

r_0 ($\times 10^{-13}$ cm.)	εr_0 ($\times 10^{-13}$ cm.)	J (MeV.)	γJ (MeV.)	Conditions satisfied
1·6	3·08	39·3	10·04	$E = 2{\cdot}185$ MeV.
1·8	3·04	31·8	9·52	$Q = 2{\cdot}73 \times 10^{-27}$ cm.^{2}
2·0	3·00	25·9	9·46	4 per cent D state
2·2	2·94	20·2	9·85	

Work is still in progress, but it is estimated that the error in the above values is well under 5 per cent, and the final results, which will be given later, should be at least accurate to 1 per cent. The value of 4 per cent for the D-state probability is deduced from the experimental values[4] of the magnetic moments of the neutron, proton and deuteron using the non-relativistic theory given in ref. 2. The validity of this theory is particularly dubious when the ranges are as small as those considered here[5]. Tables similar to Table 1 are available for D probabilities of 2–5 per cent.

Approximate sets of values have been found for $r_0 = 1{\cdot}2 \times 10^{-13}$ cm. to $r_0 = 2{\cdot}8 \times 10^{-13}$ cm., but with less accuracy than those given in Table 1. The values obtained at $r_0 = 2{\cdot}8 \times 10^{-13}$ cm. may be of interest for comparison with the (accurate) values given by Rarita and Schwinger.

Table 2

	r_0 ($\times 10^{-13}$ cm.)	εr_0 ($\times 10^{-13}$ cm.)	J (MeV.)	γJ (MeV.)	Conditions satisfied
Rarita and Schwinger	2·8	2·8	13·89	10·76	$E = 2{\cdot}17$ MeV.; $Q = 2{\cdot}73 \times 10^{-27}$ cm.^{2}. 3·9 per cent D-state
Differential analyser	2·8	2·77	13·6	10·6	$E = 2{\cdot}185$ MeV.; $Q = 2{\cdot}73 \times 10^{-27}$ cm.^{2}. 4 per cent D-state

In presenting these preliminary results, I should like to express my thanks, first to Dr. N. Kemmer, under whose helpful direction this work has been done, and also to Dr. M. V. Wilkes and Mr. B. Noble of the Mathematical Laboratory, Cambridge, the former for his generous provision of facilities in the Laboratory, and the latter for extensive and expert help and advice in putting the problem on the differential analyser.

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[1] *Phys. Rev.*, **74**, 92 (1948).
[2] *Phys. Rev.*, **59**, 436 (1941).
[3] *Phys. Rev.*, **74**, 145 (1948).
[4] Arnold and Roberts, *Phys. Rev.*, **71**, 878 (1947).
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Study of the Rheological Properties of Rapidly Thickening Colloidal Systems by Means of the Stormer Viscometer

It has been shown recently by Lindsley and Fischer[1] that by simplifying the design of the Stormer rotational viscometer and by varying the effective length of the inner cylinder to eliminate end-effect, viscosity may be expressed in terms of the relevant dimensions of the instrument, the weights used and the observed rate of revolution. Further, for Newtonian liquids the viscosity is proportional to both the actuating weight and the time for an arbitrary number of revolutions.

Independent studies in this laboratory have shown that the equation $\eta = KWt$ also gives a good estimate of viscosity when applied to the commercial Stormer viscometer[2] (with vanes and baffle) over the following ranges of variables: viscosity η from 2 to at least 75 p., actuating weight W from 100 to 500 gm., time t for 100 revolutions greater than 18 sec. The instrumental constant K was determined statistically for our instrument as $2{\cdot}93 \times 10^{-4}$. Liquids of known viscosity (glycerol solutions of various concentrations and mineral oils) were used in the investigation. For values of η between $1{\cdot}5$ cp. and 2 p., and of W between 10 gm. and 100 gm., where influences such as kinetic energy are more pronounced, an additional term is required in the

expression for viscosity, of the form suggested by Geddes and Dawson[3] for the paddle-type Stormer viscometer.

By plotting W against $1/t$ in the applicable range of the simple equation given above, straight lines through the origin are obtained for Newtonian liquids in the commercial viscometer. Deviation from Newtonian flow will be readily indicated, and the curves obtained for non-Newtonian materials will be related qualitatively to the fundamental flow curves, although they will not be of identical shape[4].

We have used this instrument in the rheological examination of various types of cold-setting adhesives which are characterized by a rapid increase in viscosity —an effect additional to any which may be produced by the evaporation of part of the liquid phase from the system. W *vs.* $1/t$ curves for any particular instant during setting were obtained indirectly by plotting t against T (the period between the incorporation of the final ingredient and the observation of t) for a series of values of W. By interpolation the corresponding values of t and W were found for arbitrary values of T, and the plotting of $1/t$ against W provided the appropriate curve.

Some thickening aqueous systems which have been explored by this method, at 25° C., include casein–lime–sodium silicate, casein–caustic soda, urea formaldehyde resin–sulphuric acid–urea, and resorcinol formaldehyde resin–formaldehyde. The casein–lime–sodium silicate glues were characterized by a fairly rapid increase in yield value with T; in casein–caustic soda glues the yield value was low and increased very slowly until the gel stage was reached. Urea formaldehyde adhesives, on the addition of the hardener, displayed considerable yield values which increased with T. Resorcinol formaldehyde resin was prepared in aqueous solution and adjusted to *p*H 6·25, which was compatible with a working life of several hours when the formaldehyde : resorcinol molar ratio was afterwards raised to 1·1 : 1, a value suitable for hardening the resin at 25° C. Practically Newtonian behaviour persisted until the abrupt transition to the gel stage. It is intended to discuss in detail elsewhere the molecular significance of these various phenomena.

The demonstration of instantaneous Newtonian flow in a system in which the viscosity is rapidly increasing may warrant the recognition of this behaviour as a distinct type. Both the criteria of Newtonian deformation suggested by the British Rheologists' Club[5] (the proportionality of shear stress and rate of shear for an arbitrary time, and of shear strain and time for constant stress) evidently refer to purely rheological conditions. The latter criterion is meant to imply, presumably, that no structural change takes place *as a result of shearing*: it is not intended specifically to exclude the case where viscosity is changing with time, irrespective of whether the system is subjected to stress, with consequent lack of strict proportionality between shear strain and time during any test extending over a finite period. However, where such a condition obtains and the first criterion is simultaneously applicable, as in some thickening colloidal dispersions, there is no reason to suppose that departure from proportionality between shear strain and time would necessarily be produced by the rheological conditions set up by shearing. The difficulty in separating the effects of flow and of polymerization nevertheless suggests the recognition of the proposed category.

The work described here was carried out as part of the programme of the Division of Forest Products of the Council for Scientific and Industrial Research, Australia. We are indebted to Mr. R. T. Leslie of the Council's Section of Mathematical Statistics for establishing, from our data, the applicability of the equation given.

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Supercooling of Mercury

Before the War, when we were working at University College, Southampton, on the solid/liquid phase change, some experiments were started on the supercooling of mercury, in order to find the degree attainable, the factors controlling it, the effect of external influences and the cause of the onset of freezing.

Mercury of very high purity was distilled *in vacuo* into two twin 'Pyrex' vessels, of a few c.c. capacity, held in identical cavities in a copper block. The space above the surface of the two samples of mercury could be evacuated or filled with known gas, as desired. More than two hundred observations were made.

Some of the results are: (1) The amount of supercooling (ΔT_f) of pure mercury in air is not usually more than a degree or two, but *in vacuo* can be increased at least to 12° C. by previous heating *in vacuo* for some hours at about 200° C. (2) Change of atmosphere above the mercury surfaces effects ΔT_f, but not necessarily immediately; for example, there was usually a lag between the admission of air and the consequent decrease of ΔT_f. (3) The direction of the change in ΔT_f produced by a given treatment (for example, heating to 200° C.) was usually the same for each twin, but the amount of change was usually different. (4) The amount of ΔT_f shown by a given twin remained roughly constant for times of the order of days, and consistently greater or less than that of the other. (5) The onset of freezing was never simultaneous in the two twins. (6) Vibration and even deliberate bumping of the whole apparatus did not induce freezing.

It seems probable that the values of ΔT_f observed were less than those characteristic of really pure mercury. The onset of freezing appears to be controlled by some additional component which can enter the mercury via the gas phase, and not by external disturbance, such as mechanical shock.

It is proposed to study the matter further.

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Brightness Variations of the Solar Corona

BAUMBACH[1] derived in 1937 the electron densities in the solar corona from a compilation of many measurements of its surface brightness. His values for N_e have proved useful in many investigations of the physical state of the corona and the radio waves emitted by it. However, for two reasons, they are not entirely accurate. First, it has now become clear[2] that only part of the surface brightness arises from electron scattering (K-component). In the outer corona the other part (F-component) is stronger. It has circular symmetry and may be ascribed to diffraction by interplanetary dust. Secondly, the brightness and shape of the corona change with the 11-year cycle of solar activity. These changes, which are partially masked by the superposition of the constant F-component, have been neglected in Baumbach's work.

A new reduction of the available data has been made. First, the ratios $f = K/(K + F)$ were obtained from the depth of the Fraunhofer lines and from the observed polarization. The change in brightness between the maximum and minimum phase was then estimated from the measured total brightness of the corona[3] and also from small changes in the relative brightness distribution. Finally, the difference between the brightness in polar and equatorial regions in the minimum phase was determined from isophotes and polarization measurements. The double method used at each step provided good checks, and the distribution finally adopted appears consistent with all data.

Let r denote the distance from the sun's centre in terms of the sun's radius. The points where the F- and K-components are equal ($f = 0{\cdot}50$) were found to be at $r = 2{\cdot}24$ in the maximum phase, at $r = 1{\cdot}93$ in the minimum phase at the equator, and at $r = 1{\cdot}28$ in the minimum phase over the pole. For the total brightness between $r = 1{\cdot}03$ and $r = 6$, divided by the sun's total brightness, we found $1{\cdot}10 \times 10^{-6}$ in the maximum phase and $0{\cdot}60 \times 10^{-6}$ in the minimum phase. The brightness of the F-corona included in either value is $0{\cdot}17 \times 10^{-6}$.

The electron densities, N_e, derived from the brightness of the K-corona by the same method as Baumbach has used, are given in the accompanying table.

Values of log N_e (cm.$^{-3}$)

r	Maximum	Minimum equator	Minimum pole	Baumbach
1·0	8·61	8·36	8·24*	8·66
1·1	8·18	7·93	7·70*	8·19
1·2	7·81	7·56	7·17	7·85
1·3	7·54	7·29	6·73	7·58
1·4	7·31	7·06	6·38	7·38
1·6	6·96	6·71	5·87	7·05
2·0	6·39	6·14	5·23	6·58
3·0	5·46	5·19	(4·18)	5·96
4·0	(4·91)	(4·66)		5·71
5·0	(4·62)	(4·37)		5·58

The values in parentheses are in a region where f is less than 0·20 and consequently uncertain. The values marked by an asterisk have to be reduced by about 0·20 (40 per cent), because a considerable part of the brightness just above the pole comes from the equatorial streamers projected on this region.

The most striking result is that the electron density varies by a factor 1·78 with the solar cycle. The opacity of the corona for radio waves varies as the square, that is, by a factor of about 3. This factor is not very certain, but it is probably between 2 and 4.

Earlier work on the radio spectrum of the quiet sun[4,5] has shown that there is a distinct change in intensity near the wave-length of 1 metre. For shorter wave-lengths the corona is transparent and only light of the photosphere (or chromosphere) is observed, with T_{eff} about 10,000°. For longer wave-lengths the corona is opaque and T_{eff} is about 1,000,000°. At wave-lengths greater than 5 m. a gradual decrease of intensity sets in again, probably because the corona becomes a partial reflector.

The brightness variation caused by the varying opacity is largest near the 1-metre discontinuity. On the rough assumption that T_{eff} equals the temperature at $\tau = 1$, a change by a factor of 3 in optical depth, τ, would change T_{eff} by a factor of 50. However, using the more accurate formula,

$$T_{eff} = (1 - e^{-\tau})\, T_c + e^{-\tau}\, T_p,$$

where T_c and T_p are the temperatures of the corona and the photosphere, respectively, we see at once that T_{eff} can change by a factor of 3 at the most. A numerical estimate shows that the change is by nearly a factor of 2 in the wave-length range from 25 cm. to 1 m. The change at shorter wave-length is smaller, because too much of the constant photosphere shines through the corona. The change at longer wave-length is also smaller, because a change in τ is not so effective when τ is large.

The old question, whether the sun is a variable star with an eleven-year period, may now probably be answered in the affirmative. The estimate is that its variations are strongest near $\lambda = 50$ cm. and that its brightness in that region oscillates by a factor of about 2. Corresponding changes in the distribution of brightness over the disk may be predicted. At the phase of minimum solar activity, the limb-brightening, combined with the lower intensity near the poles, may give the sun a certain resemblance to the dumb-bell nebula. Here is an extremely interesting field for further observations. As is known, the sun's brightness variation in the visual region, if any, is at most a few per cent.

A detailed account of this work will be published elsewhere.

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Optical Analogue of X-Ray and Electron Diffraction Patterns

IN a recent letter by J. Dyson concerning an optical analogue of X-ray and electron diffraction patterns[1], no reference is made to the previous experiments made with other models for exhibiting such analogies. A particularly complete demonstration of this type was published by Y. V. Kathavate[2] working at Bangalore. Kathavate used small circular copper disks having a uniform size of about 0·6 mm. as scattering centres. These were punched out of thin copper foil using a special technique so that the edges were free from irregularities. The disks were distributed on a glass plate, and by suitable manipula-

tion, such as bowing the edge of the plate, the disks could be made to take up any desired distribution. The Fraunhofer diffraction patterns produced by these were then photographed both in monochromatic and white light and were reproduced in four plates accompanying Kathavate's paper. They exhibit a whole range of phenomena—starting from the analogy of a gas in which the molecules are far apart giving rise to the typical corona with a central maximum of intensity, passing through the liquid stage giving a halo with a central minimum, then through a randomly oriented and a preferredly oriented polycrystal which both give spotty rings, and ending up with the analogy of a perfect crystal which gives a hexagonal array of spots.

Kathavate has also published photographs of some of the patterns in white light, in which each spot is drawn out into a radial streak. It would appear, therefore, that all the phenomena described by Dyson have already been demonstrated by Kathavate, though Dyson's application of these methods to the bubble model of a metal is of the greatest interest and importance.

There have been other investigations as well before this. For example, Prins[2] studied the optical analogy of X-ray diffraction patterns of liquids having different types of molecular distribution by using seeds scattered in varying degrees of packing. I am aware of only one case where an optical analogue has been demonstrated of a three-dimensional X-ray diffraction pattern, namely, by Sogani[4], who obtained the typical liquid diffraction pattern by using a homogenized emulsion.

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Automatic Computation of the Standard Deviation

THE irregular distribution of the mass of textile materials (yarns, rovings, slivers and tops) per unit length is by preference expressed in terms of the standard deviation :

$$\sigma = \sqrt{\frac{\sum_1^n (x_i - \bar{x})^2}{n-1}},$$

in which $\bar{x}$ is the mean mass of the textile material per unit length, and n the number of observations.

The computation of σ is a very simple matter, but becomes extremely tedious if it has to be estimated from a very great number of observations.

Several methods for the automatic computation of the variation have been developed. The following one is employed with good success at the Vezelinstituut T.N.O. The apparatus

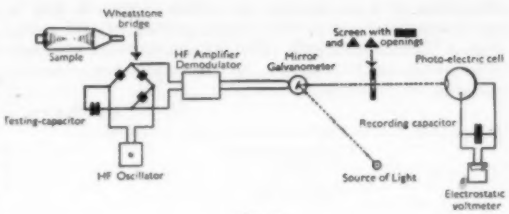

Fig. 1

consists of two parts, one of which is used for the correct transformation of the variations of mass between the feelers into electric currents and may consist of any sensitive system; and the other is the device for additive registration, which will be described here in more detail.

The latter consists of three parts : (*a*) a vacuum photo-electric cell; (*b*) a capacitor; (*c*) an electrostatic voltmeter. If no light falls on the cell, the whole system is electrostatically isolated, so that an electric charge brought to the capacitor cannot leak away (reading of the voltmeter, V_1). The device is adjusted in such a way that the amount of light falling upon the photo-electric cell is, in every position, linearly related to the mass present between the feelers of the apparatus. At the end of the experiment, the charge of the voltmeter has decreased to V_2 and the difference $V_1 - V_2$ is a measure of the total amount of light, and, consequently, of the total mass passed through the apparatus. Division of $V_1 - V_2$ by the number of observations is a measure of the mean of the mass, that is, $\bar{x}$.

The experiment is then repeated, but with the apparatus adjusted so that the decrease in charge of the capacitor is a measure of $\Sigma (x_i - \bar{x})^2$. From this, after proper calibration of the apparatus, the standard deviation can be computed very easily.

These measurements are obtained as follows. The source of light (cf. Fig. 1) throws, via the mirror of a galvanometer, a rectangular spot of light on a screen. In the first experiment the screen contains a rectangular opening, so that the amount of light passing through this opening is linearly related to the displacement of the spot of light across the screen (Fig. 2). In the second experiment the screen is replaced by one which has two triangular openings, and the spot of light is so adjusted as to fall exactly between the two openings (Fig. 3) in the mean position. The quantity of light which is transmitted

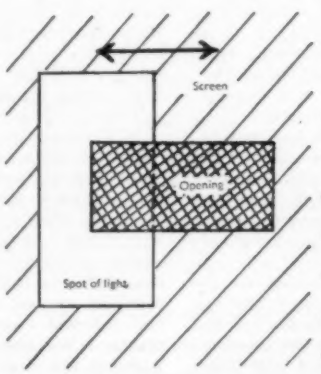

Fig. 2

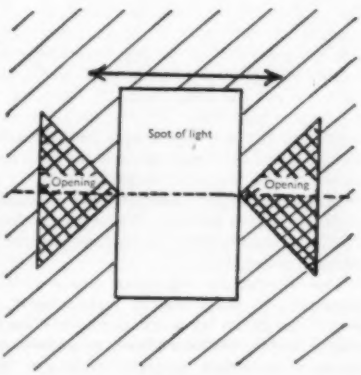

Fig. 3

when the spot is moving to either side now has a quadratic relation to the displacement of the spot. Under these conditions (Fig. 3) the sum of squared differences with respect to the average (mean) position is recorded.

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Sulphate-reducing Bacteria and Internal Corrosion of Ferrous Pipes conveying Water

THE essential function of sulphate-reducing bacteria in the *external* corrosion of ferrous pipes in anaerobic soils is now generally recognized, but little consideration has been given to the part these organisms may play in the *internal* corrosion of similar pipes conveying water.

Interior of water pipe showing nodular deposits ('tubercles') of hydrated iron oxides, beneath which sulphate-reducing bacteria develop

The formation of 'tubercles' inside ferrous pipes is a considerable source of trouble to water engineers. The tubercles are nodular incrustations (see photograph) up to 6 in. long, 4 in. broad and 1½ in. deep, and consist chiefly of hydrated ferroso-ferric oxide mixed with ferric hydroxide. According to Baylis[1], there is an accumulation of sulphate and chloride inside the tubercle. There can be very little organic nutrients present—perhaps traces from the water—but as sulphate-reducers are facultative autotrophs[2], they should be able to proliferate in the anaerobic or near-anaerobic conditions prevailing near the metal, utilizing cathodic hydrogen as source of energy. The iron underneath the nodular deposits is invariably pitted or graphitized.

The literature contains some references to the presence of sulphide in tubercles[3,4], and the descriptions given by some authors[4,5] leave little doubt that sulphate-reducers become active in the interiors. Bunker[4] detected sulphate-reducers and significant quantities of sulphide, and suggested some relation between the bacteria and corrosion. The evidence, however, is inconclusive. There is little significance in the mere presence of the ubiquitous sulphate-reducing organisms, which are to be found in most waters, while many organisms are capable of producing sulphide from organic sulphur compounds which may be present in slight traces. No determinations have been made of the amount of sulphide present, of how it is distributed within the tubercles, or of the numbers of sulphate-reducers.

This lack of significant evidence is perhaps explained by the lengthy exposure which usually occurs between excavation of the pipe and examination in the laboratory, with consequent oxidation of the sulphide and death of the organisms. Our preliminary investigations with old pipes yielded little additional evidence. Recently we have been fortunate in securing the efficient co-operation of the Metropolitan Water Board and the Barnsley Waterworks Department, which has enabled us to examine heavily tuberculated mains within two days after their removal from the soil. Our results may be summarized as follows.

(1) Tubercles examined two to three days after excavation contained considerable quantities of sulphide. The layers next to the metal contained 1·6–2·5 per cent sulphide sulphur, which is of the same order as those found in corrosion products adhering to the exterior surfaces of pipes undergoing anaerobic microbiological corrosion[6]. The middle layers contained less, the outer layers nil. The sulphide rapidly disappeared on exposure, in some cases no sulphide being found in any part of the tubercles after three weeks.

(2) Comparatively large numbers of sulphate-reducing bacteria (approximately 1,000 viable cells/gm.) were found in the interior layers of the tubercles. These numbers are approximately the same as those found by us in blackened clay on the outside of corroded pipes. Tubercles from the same pipe examined two months later contained no viable cells.

Pure cultures of sulphate-reducers were readily obtained from enrichment cultures in autotrophic medium incubated in an atmosphere of hydrogen[2,7]. Such ease of isolation of sulphate-reducers is unusual, and is perhaps explained by the almost totally inorganic nature of the environment inside a tubercle, which would only allow the development of a very limited flora.

(3) Elementary sulphur was found in appreciable quantities (at least 1 per cent). It is known that sulphides are catalytically oxidized to elementary sulphur in the presence of iron salts contained by the soil[8]. It would therefore be expected that tubercles containing a mixture of hydrated iron oxides and ferrous sulphide would, after exposure to air or to well-aerated water inside a pipe, be found to contain elementary sulphur.

(4) Severe graphitization of the cast iron was observed underneath the tubercles.

(5) The numbers of sulphate-reducing bacteria and the quantity of sulphide sulphur in the corrosion products close to the metal are roughly comparable with those obtained in anaerobic microbiological corrosion of the *exterior* of ferrous pipes. It may reasonably be inferred that the activities of sulphate-reducers are an important supplementary factor in the *internal* corrosion of ferrous pipes conveying water. We should like to emphasize that these bacteria are non-pathogenic, and have no hygienic significance except in very abnormal circumstances.

We are glad to express our appreciation of the very helpful collaboration of Mr. L. C. Whiskin, of the Metropolitan Water Board, and of Mr. Gordon Lees, of the Barnsley Waterworks Department. This note is published by permission of the Director of the Chemical Research Laboratory, Teddington.

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Effects of Bromine on Mitosis in Root-tips of *Allium cepa*

The effect of some chemicals on cells may be considered to be similar to that induced by ionizing radiation[1,2]. It seems that in such cases the specific effect of the drug is confined to the nucleus in a certain developmental stage of mitosis or meiosis, and it is characterized by the alterations induced in the structure of chromosomes, which are assumed to be conditioned by changes in the nucleic acid metabolism[3]. The chemicals acting in this manner are also known to induce gene-mutation, hence they are named 'nuclear mutafacients' or 'gene and chromosome breakers'. Sulphur and nitrogen mustards, phenol and ethylurethane belong to this group. We can now add bromine[4] as a chromosome breaker or perhaps another chemical mutafacient.

The root-tips of *Allium cepa*, 1·5–2 cm. long, were exposed to pure bromine vapour for five minutes. The root-tips were then washed for ten minutes in water, and kept in fresh-water at a temperature of 20–24° C. Squash preparations were made and stained according to the method of Darlington and La Cour[5].

Thirty-six hours after treatment, the number of cells in mitosis is greatly reduced. 120 hours after treatment the number of cells in mitosis increases slightly, and many of the dividing cells show some kind of abnormality. The first and most widespread abnormality concerns the mitotic spindle (Figs. 1 and 2). The percentage of cells with abnormal metaphase spindle and that of cells showing disturbances in anaphase is as follows:

Hours after treatment	% of abnormal		Total No.
	Metaphase	Anaphase	
36	6·2	10·9	357
48	9·1	15·4	222
72	13·8	23·2	202
96	20·7	32·1	176
120	20·1	24·7	275

We found that the formation of polyploid cells is very frequent, no doubt due to spindle disturbances. Forty-eight hours after treatment, 27·2 per cent polyploid cells were observed. Chromosome and chromatid breaks, followed by the formation of acentric fragments (Fig. 2) and anaphase bridges, were seen; the latter are due to reunion between broken chromatids. Nucleic acid starvation, that is, a reduced charge of nucleic acid in the chromosomes of some cells, was seen (Figs. 3 and 4), which suggests that the effect of bromine may be specific, being concerned either directly or indirectly with nucleic acid metabolism. The effects induced may be summarized as follows:

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 1. Displaced chromosome showing chromatid break at anaphase, 36 hours after treatment. (× 1,500)

Fig. 2. Abnormal crowding of chromosomes at metaphase and a displaced acentric fragment, 120 hours after treatment. (× 1,500)

Figs. 3 and 4. Despiralization of chromosomes during prophase and metaphase due to nucleic acid starvation, 120 hours after treatment. (× 1,500)

1. Bromine acting for five minutes on the root-tips of *Allium* has a specific effect on the cell nucleus in the resting stage.

2. The effects induced are shown thirty-six hours after treatment by spindle abnormalities in metaphase and anaphase, and result in polyploidy in a large number of cells.

3. Bromine produces chromosome and chromatid fragmentation; the latter may be followed by reunion.

4. The effect of the bromine is cumulative and depends on the time which elapses between treatment and fixation.

5. The cytological effects induced by bromine strongly suggest that it is another specific mutafacient chemical.

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Morphological Variability of the Nuclear Substance and Genetic Changes induced by Colchicine in *Escherichia coli*

After the simple and reliable proof was given of a nuclear substance of desoxyribose type in bacteria by Robinow's method, a number of authors followed its physiological changes with regard to the growth-cycle of bacteria[1-3]. We have tried to determine the effects of chemical substances, which in higher organisms act on the nucleus and its division, on the nuclear substance of desoxyribose type and its physiological cycle in bacteria.

We used for our experiments colchicinum crystal, colchicinum amorphum and colchicinum chloroform. The effect of colchicine was controlled by other polyploidy agents such as chloral hydrate and veratrin. The substances were added to broth, to Koser's synthetic medium with glucose, and to solid agar medium in increasing dilutions of 1 : 500 to 1 : 500,000. In the eight strains which we used in our experiments, we studied first thoroughly the normal morphological and biochemical properties. The chromatin structures were stained by Robinow's method.

In 24-hr.-old cultures, we observed splitting of the nuclear substance either into disconnected particles in the cytoplasm or into a number of minute 'nuclei' irregularly distributed within the cell. These forms of nuclear substance were not observed in cultures with chloroform–colchicine and with the control agents. After cultivation for 48 hours, the bacterial cell lengthened, and in bacteria which normally have no more than four nuclei there were six to eight of them. Later, long polynuclear ('polyploidy') cells developed (these forms arise also with chloral hydrate and veratrin treatment), branched long cells and often whole mycelium-like nets.

At the same time we wished to ascertain whether also the biochemical properties of bacteria change with these morphological changes of the nuclear substance of desoxyribose type. Among the eight strains of *Esch. coli* used were three which could not utilize sucrose. During very many cultivations of these strains in media with sucrose, it was not possible to 'adapt' them or to get spontaneously a sucrose-fermenting mutant. By the analysis of cultures with colchicine, we found, in all sucrose-non-fermenting strains, biochemical mutants which were able to utilize sucrose. We obtained such mutants after cultivation for 24 hours, that is, exactly at the time when the disturbance of the nuclear substance and the minute 'nuclei' could be observed. We detected the mutants on the solidified Koser's medium with sucrose as the sole source of carbon, and added as an indicator bromthymol-blue. On this medium sucrose-fermenting bacteria become yellow colonies of normal size. The adult colonies, which should possess the newly acquired biochemical properties, were then examined in order to determine whether they were real mutants and whether their new characteristics were stable and hereditary.

These experiments thus show that the action of colchicine not only induces morphological changes of the nuclear material of a desoxyribose type in *Esch. coli*, but also simultaneously enables us to detect biochemical mutants. Detailed descriptions of our results will be given elsewhere[4].

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Recovery and Culture of Tubal Mouse Ova

Fertilized mouse ova have been cultivated *in vitro*, and their development filmed, by Friedrich-Freksa and Kuhl[1], who used as medium a clot of guinea pig plasma and mouse embryo extract containing segments of Fallopian tube[2]. Like Chang[3], I have been working on ovum culture with a view to transplantation of ova. Chang has used rabbits, with serum as a culture medium; I have chosen to use mice, as more readily available, and because (like most domestic animals) they have naked eggs. Seeking a medium readily prepared in large quantities, I have tried saline hen-egg extracts.

The procedure adopted revealed an unanticipated difference between the viabilities of two-cell and later tubal stages; eight-cell ova survived and developed in culture, whereas two-cell ova did not.

Saline (NaCl, 880; KCl, 30; $CaCl_2$, 25; $MgCl_2$, 5; glucose, 108 mgm. per cent; and NaH_2PO_4, 10 mgm. per cent), with 8–9 c.c. of thin egg-white added per 100 c.c., was used as a clear fluid for recovery of ova. This fluid (*p*H 7·5–7·8) was stored in the refrigerator and used up to fourteen days after preparation.

Eight-cell ova have developed when incubated in this fluid, but normally the recovered ova were transferred to a medium, freshly prepared from saline and from yolk and white separately stored. It had the same composition as the fluid used for recovery, except that the acid phosphate was omitted and egg yolk added (about ½ vol. per vol. of egg white). This fluid (*p*H 7·2–7·4) was centrifuged before use, but a small deposit was formed in the culture dishes after two days in the incubator.

After killing the mated mice, their uteri, Fallopian tubes and ovaries were transferred to egg-white–saline at room temperature. Incisions at ovarian and uterine ends freed the tubes, which were then flushed with a glass cannula having a small terminal bulb which was inserted into the finer, but more robust, uterine end of the tube. This procedure takes only a few minutes and the efficiency of recovery is quite high. One day after a copulation plug had been observed, the ova were usually at the two-cell stage; a day later they were generally eight-celled; four-cell ova were not often encountered.

Groups of one to six fertilized ova were transferred to vessels containing 2–3 c.c. of the yolk extract and 1–2 c.c. of air. The vessels were sealed and incubated at 37° C. After 42–52 hr. the ova were re-examined. No two-cell ova so treated developed beyond the four-cell stage; the very few three- and four-cell ova found on re-examination may have been mistakenly identified as two-cell before explantation.

Ova at the four-cell stage sometimes developed. Nearly always, four-cell ova were recovered from mice having also either two- or eight-cell ova; of seven found with two-cell stages, one only developed, while of twelve found with eight-cell ova, only one failed to develop.

Eight-cell ova (and the few six- to twelve-cell observed) without exception developed into blastulæ or blastocysts. Some did not get beyond the stage of blastulæ, completely encased in the zona pellucida. A few became blastocysts either completely separated from the zona, or spherical and still half-enclosed in the split and distended membrane. The majority had apparently developed to this latter stage, and then the blastocyst had collapsed and been constricted by the zona into a figure-of-eight shape. Possibly longer survival could be obtained by subcultivation.

Cultures in yolk extract

	Cell-stage at recovery	Number of ova	Development after 2 days
A 43 cultures	2	47	None
	4	9	4 None. 5 Blastula or blastocyst
	8	44	All blastula or blastocyst
B 15 cultures	2	36	None (one 4-cell)
	4	10	3 None. 7 Blastula or blastocyst
	8	21	All blastula or blastocyst

The results of a number of cultures in yolk extract are summarized in the table. Series *A* refers to cultures in which the ova in individual cultures were derived from the same mouse. For series *B*, pairs of mice were killed, their Fallopian tubes dissected and flushed in the same fluid, and cultures put up containing both two-cell and eight-cell ova.

A physiological difference between two-cell and eight-cell stages seems clearly established; the reason for the difference remains obscure. The result recalls a similar one of Chang's[4], namely, survival of morulæ, but not of two-cell ova, when transplanted into the rabbit uterus, though both survived when cultivated in serum.

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Influence of Some Lipoidal Substances on Aggregate Formation in Soils

FOR crop production, soil should have a good crumb structure, the crumbs being highly adsorptive of water but stable when wetted. The ameliorative effect of certain microbial polysaccharides on soil structure has already been reported[1], and it was of interest to see whether other constituents of micro-organisms have a similar effect.

When the mycelia of *Penicillium notatum* and *Aspergillus niger* were extracted in a Soxhlet with a 1 : 2 alcohol–benzene mixture, dark fatty products were obtained which resembled materials obtained from wheat straw and from soil. We have studied the effect of these products on a soil, the natural structure of which in terms of water-stable aggregates is extremely poor. Samples of this soil were air-dried, ground to pass through a 52-mesh B.S.S. sieve and treated with solutions of the products. When the solvent had evaporated, sufficient moisture was added to bring the soil to the 'sticky point'; in this state it was pressed through a 3-mm. sieve and the aggregates were dried at 50° C. In another experiment the same procedure was followed except that solutions of the products were sprayed on the surfaces of preformed aggregates. In both cases the water stability of the aggregates was determined by a wet-sieving technique[2]. Results are shown in the accompanying table.

Influence of extracts of fungal mycelia, wheat straw and soil on the stability of soil aggregates

Materials extracted	Solvent	Amount added to soil (per cent)	Aggregation (per cent)	
			Incorporated in soil aggregates	Sprayed on the surface of soil aggregates
			(mean of 2 expts.)	(mean of 2 expts.)
Mycelium of *Penicillium notatum*	Alcohol–benzene	0·5	5·3	20·3
		1·0	8·6	28·0
Mycelium of *Aspergillus niger*	Alcohol–benzene	0·5	8·2	23·6
		1·0	17·0	41·1
Wheat straw	Alcohol–benzene	0·5	1·6	18·9
		1·0	9·2	33·0
Soil	Ether	0·5	1·0*	9·1
		1·0	8·0*	17·6

Percentage aggregation of control (mean of 8 determinations) = 1·7.
* Single determination only.

Analysis of variance showed that the differences in percentage of water-stable aggregates between the different extracts and between rates and methods of application are all highly significant. Further, it was observed that these aggregates, particularly those sprayed with the extracts, were so difficult to wet that they floated indefinitely when placed on the surface of water, a sure indication that the aggregates were waterproofed.

The soil extracted yielded 0·4 per cent fatty material, and it is concluded that this amount, unless it occurs as a coating on the surfaces of aggregates, is too low to have any great influence on the degree of soil aggregation. Also, any aggregates so formed would be waterproofed, which would probably limit their value in improving soil productivity.

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Dietetic Necrosis of the Liver: the Influence of α-Tocopherol

In 1935, T. E. Weichselbaum[1] demonstrated that rats on a diet poor in sulphur-containing amino-acids developed 'hæmorrhages' in the liver. Four years later, Gyorgy and Goldblatt[2] established that these were, in fact, areas of necrosis, and in 1945 Glynn, Himsworth and Neuberger[3] showed that the factor in protein, lack of which caused such necrosis, was cystine. But since that time it has become clear that, even when similar diets are used, there are surprising discrepancies between the results obtained in different laboratories; some investigators producing the lesion regularly, others occasionally, and some not at all[4]. In view of the fact that much work is being started in this field, it may be useful to make known without delay the results of a pilot experiment which seems to throw some light on these discrepancies.

In 1944, Schwartz[5] produced a necrosis of the liver in rats by means of a diet containing as much as 15 per cent of an alkali-treated casein, but observed no lesions when crude casein was used. This lesion was prevented by wheat germ oil, and later the protective factor was shown to be tocopherol. Owing to the War, Schwartz's results remained unknown until very recently and, quite independently, Paul Gyorgy of Philadelphia[6] produced evidence pointing to a similar conclusion. Searching for an explanation of the irregularity with which his diets produced liver necrosis, he noted a relationship between the incidence of the lesion and the type of dietary fat and, later, correlated this with the tocopherol content of the fat. He then showed that the incidence of liver necrosis in animals receiving diets deficient in sulphur-containing amino-acids was decreased by giving supplements of tocopherol, although adequate dietary cystine prevented the lesion even when the supply of tocopherol was deficient.

On learning of Gyorgy's results, we placed two groups of rats on the yeast protein diet which we had found most effective in producing massive hepatic necrosis. One group was given a supplement of 15–20 mgm. of α-tocopherol twice a week; the other received none. All the eleven animals which did not receive tocopherol showed massive hepatic necrosis or its sequel, post-necrotic scarring; only one of the eight animals receiving the supplement showed any trace of liver damage. We then communicated with the workers in Great Britain who had failed to produce necrosis by diets stated to be identical with ours. In each case we found that tocopherol had been added to the vitamin supplements we had prescribed, under the impression that we had forgotten to mention it in our communications. One investigator, thereupon, repeated his experiments, omitting the tocopherol supplement, and produced necrosis for the first time in his experience.

But these results did not entirely resolve the discrepancies. Over the last two years we were forming the impression that, while we were still able to produce the lesion in all animals, it was taking longer to do so, and, further, the lesion tended to be milder. Again, in other laboratories, even when tocopherol was omitted from the diet, the incidence-rate of necrosis was rarely more than 30 per cent as compared with the 100 per cent in our laboratory. On considering these points, it occurred to us that there were strong indications that the body held tenaciously to its tocopherol stores and that, in consequence, the nature of the pre-experimental diet might be of importance to the success of the experiment. Accordingly, we took two groups of rats on weaning and put both on a diet calculated to produce tocopherol deficiency, but supplemented the diet of one group with tocopherol. After 110 days on these diets, both groups were placed on the diet low in sulphur-containing amino-acids and tocopherol which had proved effective in producing liver necrosis. At the time of writing, 104 days after starting the necrogenic diet, eight of the eleven animals which did *not* receive supplements of tocopherol in the pre-experimental diet are dead of necrosis; the eight rats which did are alive and well.

We do not claim that these findings completely explain the discrepancies between the results from different laboratories. What we do suggest is that investigators planning experiments on dietetic massive necrosis of the liver should pay attention to the diet eaten by their animals in the pre-experimental period, and to ensure that it is not rich in tocopherol.

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Two New Cardiac Glycosides, Rubellin and Transvaalin, from South African Species of *Urginea*

The isolation of rubellin from *Urginea rubella* by me was mentioned by Sapeika[1]. Compared with ouabain, standard strophanthidin B.P. 1932, lanatoside C, digoxin, and digitoxin, rubellin is the most active glycoside[2].

The glycoside was prepared in 0·015–0·045 per cent yield by shaking out concentrated aqueous extracts of the bulb with ethyl acetate. On concentration of the ethyl acetate extracts, the glycoside crystallizes spontaneously. Rubellin has melting point 261–263° C. and $[\alpha]_D^{27} = 15{\cdot}81$ (methyl alcohol).

Analysis. C = 59·06, 59·09, 58·95, 58·65 per cent.
H = 6·55, 6·64, 6·43, 6·43 per cent.
Mol. wt. = 656.

Calculated for $C_{30}H_{48}O_{10}$: C = 58·69 H = 6·56 per cent. Mol. wt. = 736·7.

Transvaalin was isolated from *U. burkei* (Transvaal slangkop) in approximately 0·01 per cent yield by shaking out concentrated aqueous extracts of the bulb with chloroform–alcohol (10 : 1). The glycoside was retrieved from the chloroform–alcohol shake by washing with water. The water extract was evaporated to dryness and the residue recrystallized from 96 per cent alcohol, yielding the glycoside with ultimate melting point 193–194° C. and $[\alpha]_D^{20} = -73{\cdot}26$ (methyl alcohol).

Analysis. C = 61·08, 61·19, 61·19, 61·02 per cent.
H = 7·714, 7·943, 7·952, 7·759 per cent.
Mol. wt. = 672.

Calculated for $C_{28}H_{44}O_{14}$: C = 60·66; H = 7·92 per cent. Mol. wt. = 713.

Both rubellin and transvaalin give negative Legal tests but react positively in the Molisch and Liebermann tests. The ultra-violet absorption spectra of rubellin and transvaalin are very similar and are practically coincident with that of scilliroside[2]. Rubellin and transvaalin have maximum absorption at 297 mμ with $\log E^{1\ \text{mol./litre}}_{1\ \text{cm.}} = 3{\cdot}80$ and at 299 mμ with $\log E^{1\ \text{mol./litre}}_{1\ \text{cm.}} = 3{\cdot}64$, respectively.

Rubellin reacts towards rats as a cardiac poison whether it was administered *per os* or by intraperitoneal injection. Transvaalin, however, even in large doses, only reacts as a typical rat poison, namely, by its action on the central nervous system.

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Paper Chromatography of Pterins

The detection and identification of pterins in small quantities was carried out by Schöpf and Becker[1] in the course of their classical work on this class of pigments. They employed a chromatographic technique using 0·004 *N* aqueous hydrochloric acid or 0·01 *N* methyl alcoholic hydrochloric acid solutions on micro-absorption columns of alumina or frankonite. The technique of paper chromatography has now been applied successfully to certain of the common pterins, and as a result a method has been elaborated for the rapid identification of very small quantities of these compounds such as may be obtained by extraction of individual butterfly wings. Indications that this method might be applied in the pterin series had been given by Crammer[2], who mentioned that xanthopterin and leucopterin could be concentrated by a paper chromatographic technique.

We have found that the butyl alcohol – acetic acid mixture of Partridge[3] is the most satisfactory solvent for the separation of mixtures of pterins, which were used as 0·1 per cent solutions in 0·5 *N* ammonium hydroxide. After development of the chromatogram and removal of the solvent, the paper was viewed in ultra-violet light, when the individual pterins were easily located by their characteristic fluorescence. The accompanying R_F values were obtained for the individual pterins (Table 1).

In the case of xanthopterin, three spots were generally obtained, of which (*c*) was ascribed to xanthopterin itself. The purple fluorescing material (*b*) was stated by Schöpf and Becker[1] to be a decomposition product of xanthopterin, but the exact nature of this compound is obscure. It was also observed in a number of butterfly wing extracts (see below). The nature of the third spot (*a*), which was less intense than (*b*) or (*c*), likewise remains unknown; it, too, was observed in some of the butterfly wing extracts.

Table 1

Pterin	R_F value	Colour of fluorescence
Leucopterin	0·12	Pale blue
Xanthopterin	(*a*) 0·08 (*b*) 0·27 (*c*) 0·38	Pale greenish-blue Purple Yellowish-green
Rhizopterin[4]	0·56	Bright blue

The method has been applied to extracts of the wings of various Pieridæ known to contain pterins, and the following components were identified (*a* and *b* refer to the unidentified spots obtained from xanthopterin in Table 1).

Table 2

Pieris brassicæ L.	♂♀	Leucopterin; (*b*)
P. napi L.	♂♀	Leucopterin; (*b*); uric acid Xanthopterin (trace)
Euchloë cardamines L. (orange tips of wings only)	♂	Erythropterin (?) Leucopterin; (*a*); (*b*); Xanthopterin.
Catopsilia argante F.	♂	Erythropterin (?); Leucopterin: (*a*); (*b*) Xanthopterin
Gonepteryx rhamni L.	♂	Leucopterin; (*a*); (*b*); Xanthopterin

The species *E. cardamines* and *C. argante* were stated by Schöpf and Becker[1] to contain the red erythropterin, and it was observed that in these cases a reddish-yellow spot ($R_F = 0{\cdot}13$) was obtained immediately below the leucopterin spot. As pure erythropterin has not been available to us, we have been unable to identify this compound with certainty; but it does appear to correspond to the product described by the German workers. The isolation of uric acid from the wings of mixed Pieridæ (including *P. napi*) has been described by Tartter[5].

The insect *Onchopeltus fasciatus* Dall. (Lygæidæ) contains an orange-red pigment which is thought to belong to the pterin class, and this pigment has likewise been subjected to paper chromatographic analysis. The results showed that the colouring matter was a mixture of erythropterin, leucopterin, the purple fluorescing 'pterin decomposition product' and an additional compound with a pinkish fluorescence ($R_F = 0{\cdot}04 \pm 0{\cdot}02$). Other applications of this facile method of identification of pterins are at present being studied.

We are indebted to Prof. A. R. Todd and Dr. V. B. Wigglesworth for their advice and interest in this work, and gratefully acknowledge the gift of specimens of rhizopterin and xanthopterin from Dr. E. L. Rickes, Merck and Co., Inc., Rahway, New Jersey. One of us (P. M. G.) has received a grant from the Medical Research Council.

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ELECTRON MICROSCOPY CONFERENCE

THE development of the electron microscope as a routine tool in research has gone forward very rapidly in recent years. By 1939 the main features of its design had been settled and the magnetic type had become commercially available. By the end of the War a great variety of specimens had been examined in it, and preparative techniques adapted to different materials were being worked out. The initial phase of exploring the range of its applications was over, and in the succeeding three years the electron microscope has begun to take its place as a regular adjunct to the established optical methods of microscopy. Solid contributions to knowledge have been made which would have been impossible but for the help of the new instrument.

The present position was clearly reflected in the subjects discussed at the Conference held at the Cavendish Laboratory, Cambridge, during September 20–23, organised by the Electron Microscopy Group of the Institute of Physics. Four half-days were devoted to applications of the instrument, three being on biological subjects and one on metallurgical work. Two sessions were occupied with papers on techniques and on the microscope itself. The attendance was around a hundred at each session, although the composition varied considerably with the topics under review. There was a large contingent of visitors from abroad, including Belgium, China, France, Holland, Poland and Sweden, as well as Canada and the United States.

In the field of metallurgy the methods of electron microscopy are as yet neither so well established nor their usefulness recognized as in its biological applications. The various ways of getting replicas from metal surfaces are in process of being checked against the results of optical microscopy. A means of dealing with relatively rough surfaces has recently been devised[1], in which aluminium is forced against a (harder) surface and receives an imprint of its relief. The aluminium block is detached, and an oxide replica made on its surface by established methods, which is then examined in the electron microscope. A comparison of the new method with the Formvar stripped film method was described by A. F. Brown, V. E. Cosslett and J. Nutting, of the Cavendish Laboratory, and its advantages for the examination of deeply etched or fractured metals discussed. The place of silhouette photography as a complement to replica methods, in the study of slip processes, was treated by A. F. Brown.

Two examples of the application of electron microscopy in the study of metals were given. J. Trotter (National Physical Laboratory) dealt with the changes in microstructure which occur in a 0·6 per cent carbon steel when tempered at different temperatures from 100° to 700° C., using the plastic replica method. The surface damage due to metallic sliding contact was the subject of a paper by J. R. Whitehead, of the Physics and Chemistry of Rubbing Solids Laboratory, Cambridge. The plastic flow and plucking of one metal by the other, which are found with loads of a milligram, are essentially similar to the observations made with heavy loads.

In the biological sessions it was notable that most of the communications were concerned with new developments in specimen technique as much as with their application to problems in biology. C. E. Hall, of the Department of Biology, Massachusetts Institute of Technology, reviewed the work which is being carried on there on the study of periodicities in biological fibres[2], such as collagen and fibrin. In some cases the banded structures, which repeat regularly at characteristic intervals of the order of hundreds of Ångström units, have been correlated with the long-range order deduced from X-ray investigations. In the case of fibrin the length of the fibre-axis period is found to be about 230 A., and each period consists of at least two alternating but dissimilar bands, which can be stained with phosphotungstic acid. The physical-chemical data, on the other hand, indicate a length of 700 A. for the elementary filaments composing fibrin, which bears no obvious relation either to the band period or to the distribution of length observed in electron micrographs of fibrinogen fibrils.

The work at the Massachusetts Institute was carried out on fibres isolated from their natural matrix. Two papers were devoted to studies of the detailed architecture of tissues. R. Reed and K. M. Rudall (Department of Biomolecular Structure, University of Leeds) reported on the application of the method of layer-stripping, previously developed by them for the investigation of muscle structure[3], to the study of connective tissue. Successive layers of the tissue may be exposed in turn, the structure in each being made visible in a gold-replica. From the results, an attempt is being made to define the structure and inter-relationship of the various components: collagen, reticulin, cementing substances. The use of a similar procedure was described by H. Fernandaz-Moran (Nobel Institute for Physics, Stockholm), who, however, examined the gold-shadowed and stripped tissue layers directly in the electron microscope, without removing by enzymatic digestion the biological material, as is done by the Leeds workers. He is engaged in an examination of medullated nerve fibre sections, and the preliminary results show the general arrangement of the neuro-tubules in the axis and surrounded by dense collaginous material.

An alternative method of providing sufficiently thin layers for penetration by the electron beam is to dissect or peel them from the organism or to collect naturally sloughed sheaths. In this way it is possible to examine insect cuticle layers directly in transmission instead of by replicas. M. J. Way (Rothamsted Experimental Station), with V. E. Cosslett and D. A. Taylor (Cavendish Laboratory), described the results obtained from the tomato moth larva. The tubercular structure of the epicuticle and its immediately over- and under-lying layers is clearly revealed, with the form of the pore canals running down into the endocuticle. The latter has a less well-defined layer structure, which is less amenable to investigation, although some success has been obtained in cutting very thin microtome sections.

H. Hurst (Department of Colloid Science, Cambridge) showed electron diffraction diagrams obtained from insect cuticle, and from the cell membranes of bacterial and yeast colonies, as compared with similar patterns from thin artificial collodion-lipid layers[4]. There is evidence of greater stability of the lipid layers in the natural membranes. Changes in pattern may be correlated with changes in membrane

permeability produced by fat solvents, detergents and organic reagents.

The fine structure of the lamellar pseudopodia was described by Prof. E. Faure-Fremiet and M. Bessis (Collège de France, Paris), in a paper which well brought out the interdependence of electron and optical methods. The lamellæ developed by these organisms have a thickness of about 0·2 micron, and appear to have a fine structure composed of granules about half this size.

In all these cases the material was dried before insertion in the electron microscope, or before taking a replica from its surface. A considerable advance in technique, and probably the most important presented at this Conference, is the development of a method of taking replicas from wet biological specimens by Prof. J. Wolf (Institute of Histology, Charles University, Prague), described in a paper read for him by A. F. Brown. It is a variant of his original replica method for optical microscopy[6] and employs a solution of 'Palapont' (synthetic plastic) in chloroform, which, after setting, is removed from the specimen with adhesive collodion tape. Microrelief films are obtainable from both natural surfaces and from the surfaces of cut sections. The latter are of especial interest, as their form is determined by properties of the material other than those which determine visibility in the optical microscope (refractive index or affinity for dyes). Examples were shown from sections through the cells of the secretory glands, brain, liver and other organs, and of the natural surfaces of the stomach, urine bladder and of teeth.

A number of papers were concerned with observations on particulate systems. Prof. R. C. Williams and R. L. Steere (University of Michigan) described experiments on plant viruses, in which material direct from the host was examined in a search for evidence of virus multiplication. Some evidence of binary fission was obtained from young, rapidly growing infections of tomato bushy stunt virus. Examination of tobacco mosaic virus in crude unpurified juice showed large plaques or sheaves of virus rods, which break up into particles of reasonably uniform length on the slightest mechanical or chemical disturbance of the juice. I. M. Dawson and W. J. Elford (National Institute for Medical Research, London) described their technique for adsorbing animal viruses on to the surface of chick red cells. This avoids the objections to the normal centrifugation method and yields an excellent sample for particle-size determinations. The laked cells have been successfully used for isolating the viruses of influenza, Newcastle disease, fowl plague and mumps. Fundamental aspects of cell – virus interaction become open to investigation by this new technique.

As with viruses, so also with bacteria it is important to devise means for examining them in the electron microscope in a state as near as possible to their natural mode of growth. E. M. Brieger and V. E. Cosslett have been concerned with this problem in studying the development of tubercle bacilli[8]. In order to enable the cultures to be fixed and sterilized without disturbing their natural arrangement, a method has now been devised of growing them directly on collodion-covered specimen grids. It has permitted the investigation to be extended from the avian to the bovine strains of tuberculosis, and has succeeded also with *Mycobacter phlei* and *B. subtilis*. It should find general application to studies of bacterial development.

A further biological subject was introduced by K. B. Merling (Middlesex Hospital, London), who described some observations on coli bacteriophage. Characteristic thickenings of the end of the tails were observed in gold-shadowed preparations. Accurate photography was only possible with the aid of a newly developed fluorescent screen coating, of high visual contrast.

A group of papers was devoted to new uses of electron lens systems. C. E. Hall (Massachusetts Institute of Technology) gave an account of the technique and some results of his improved method of dark-field microscopy[7]. With amorphous objects the contrast and resolution are inferior to that obtained in bright-field images. But in crystalline materials the contrast is enhanced by the occurrence of Bragg reflexions, and the resolution then approaches that obtainable in bright field. The dark-field method is thus particularly useful for detecting crystalline components in a specimen. L. Marton (National Bureau of Standards, Washington) described his electron optical adaptation of the *Schlieren* method of photography[8], which permits the micro-exploration of electric and magnetic fields in terms of the dark-field image obtained. Applications of the method to the investigation of the field distribution along magnetic recording tape and around Bitter domains were described. H. Boersch (Institut des Recherches, Tettnang) gave the first description of a method of filtering from the electron beam all particles which have suffered more than a given energy loss. A counter-field is employed, formed by an electrode at the potential of the cathode, less a variable additional voltage, which thus rejects all electrons which do not exceed this net value. In this way it is possible to filter from the imaging beam all electrons which have suffered appreciable inelastic scattering in a specimen, and which normally depreciate the contrast in the image. With specimens carried on collodion film, the reflexion of all electrons that had lost 3 volts or more of their original 50 kV. resulted in a considerable improvement in contrast. In the case of electron diffraction patterns the effect is even more striking, resulting in almost complete suppression of the central diffuse spot and increased visibility of rings of low order. The immediate benefit of the method is therefore likely to be greater in regard to low-angle electron diffraction than in electron microscopy.

In matters of technique, Prof. N. Hast (Royal Technical College, Stockholm) described improvements in his method of obtaining very thin films of beryllium and aluminium[9] for use as specimen supports. If the metal is deposited (*in vacuo*) on thin films of a liquid of low vapour pressure, such as glycerol or mercury, thicknesses of the order of 10–20 A. can regularly be removed and mounted intact on specimen grids. R. C. Backus and Prof. R. C. Williams (University of Michigan) reported on the uses of a polystyrene latex, which forms spherical particles of remarkable uniformity of size. They are ideal objects for the calibration of electron microscope magnification. The provisional value of their size is 2,570 ± 15 A., with most of the probable error residing in the measurement rather than in true dispersion of size. R. Reed and A. Millard described the use of the layer-stripping method in the examination of the grain size of photographic emulsions; a gold film is evaporated at an angle on to the surface, backed with collodion, and the underlying gelatine then removed with enzymes. Preliminary results on

the variation in grain size and distribution with photographic characteristics were presented.

The final session was devoted to the development of the electron microscope itself. E. de Haas (Allmänna Svenska Elektriska Aktiebolaget, Vasteras) gave a short account of the Siegbahn–Schonander magnetic type, but the main theme for discussion was the high-voltage electron microscope. L. Marton (Washington) dealt with the theoretical requirements of such an instrument, and gave some details of the construction of a microscope to be used with the 1·4-MeV. installation at the National Bureau of Standards. The increased beam penetration and reduced energy losses which will result should allow much thicker specimens to be examined; this is especially important for biological work, where it should become possible to examine wet objects and perhaps even living organisms. At Washington, a monochromator formed by three magnetic deflecting fields is used to obtain a sufficiently homogeneous electron beam. H. Bruck, M. Bricka and P. Grivet (Sorbonne, Paris) discussed the use at very high voltage of an electrostatic microscope, in which the focal length is independent of voltage variations, apart from a relativistic effect. It can be shown[10] that in the region of 1 MeV. the focal length of an electrostatic lens has a maximum value, at which there remains only a quadratic relativistic chromatic aberration of very small magnitude. The spherical aberration is large, but is more than offset by the reduction in the diffraction error arising from the smaller wave-length of the illumination. Owing to space limitations the Paris project employs two magnetic rather than electrostatic projection lenses, in a microscope designed to operate in the first place at 500 kV. The immediate problem is to design a compact electrostatic objective of high enough electric strength. A pressurized electrostatic generator is employed to provide the high tension.

A. C. van Dorsten (Philips Laboratories, Eindhoven) described the magnetic instrument constructed there to operate at 400 kV. The microscope column is of the same type as the 100-kV. Philips instrument, having three-stage magnification. The high-tension supply is of the conventional type, but a compact pressure-tank is now being made to replace it. The results so far obtained with bacteria and yeast cells as test objects demonstrate the expected extension of visibility through thick specimens, and, against expectations, a comparatively minor decrease in photographic contrast. The practicability of an electron microscope for a voltage of 400 kV. is thus proved, and the results are encouraging for projects aiming at even higher voltages.

The two concluding papers were concerned with properties of electrostatic lenses. P. Grivet and L. Regenstreif (Laboratories of the Compagnie Générale de Télégraphie Sans Fil, Paris) described the improvements made in their objective lens, as a result of theoretical investigations into the effect of asymmetries of construction on its aberrations. Such an objective has now been included in an experimental three-stage electrostatic microscope, some photographs from which were shown. They exhibit a resolving power higher than anything previously obtained from an electrostatic system, and approaching the best performance obtained with a magnetic machine (between 10 and 20 A.). W. A. Le Rütte (Institute for Electron Microscopy, Delft) discussed the use of electrostatic systems for projection purposes. It appears that a three-electrode lens can, within a defined range of dimensions and operating conditions, project an image free from distortion and of wide aperture (1 : 2). Similar results are obtained for two- and three-electrode mirrors, and the possibility now appears of employing an electrostatic mirror as projection unit in an electron microscope.

A number of other meetings were arranged in connexion with the Conference. An informal discussion, opened by G. Liebmann (Associated Electrical Industries Laboratories, Aldermaston) and W. A. Le Rütte, took place on the abstracting of papers in electron microscopy. As an outcome, plans are going forward for the preparation of a regular bulletin of titles and abstracts of papers by the Electron Microscopy Group. Smaller informal meetings were also held of users of particular types of microscope. An exhibition of electron micrographs was arranged, in which the breadth of its applications was displayed; and Prof. Marton showed his film of the construction of the Stanford electron microscope. A Conference dinner was held in King's College on September 21. Altogether it can be said that the meeting was on a higher level and more successful than any of those previously arranged by the Group.

V. E. Cosslett

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LUNAR VARIATIONS IN THE PRINCIPAL IONOSPHERIC REGIONS

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It has recently been found[1,2] that semi-diurnal lunar variations are derivable from the routine measurements made at ionospheric observatories. These variations are found not only in the heights of all the principal ionospheric regions, but also[1] in the maximum electron densities of the F_2 region. Near the magnetic equator they are found to be very large indeed, the height variations being at certain times some fifty times greater than the already large variations previously found by Appleton and Weekes[3] in the E region.

It is natural first to seek to interpret these variations in terms of the tidal vertical rise and fall of isobaric surfaces in the ionosphere. The detailed application of such ideas leads, however, to grave difficulties, even when allowance is made for the magnification and phase changes of such tides found theoretically by Pekeris[4] at high atmospheric levels.

A way out of such difficulties appears[5] when account is taken of the permissible electron movements in the ionosphere under the influence of the *horizontal* tidal air movements. At the low pressures existing there, electrons are constrained to move along the lines of the earth's magnetic field. Thus, at moderately high latitudes, electrons (and ions) move with a vertical velocity component which is of the same order of magnitude as the horizontal air velocity. At low latitudes this effect diminishes, owing to the loss of inclination in the earth's magnetic field. At these latitudes, however, the polarization field[6] produced by the 'dynamo' action of the tides becomes large, and produces vertical electron drift *in the opposite sense* to that occurring simultaneously on the same meridian at high latitudes (greater than about 35°).

Another, and formally identical, way of looking at this phenomenon is to consider the current whirl set up in each region of the ionosphere by the 'dynamo' action of the air tides. The reaction between this closed current circuit and the magnetic field of the earth produces mechanical forces which tilt the ionospheric circuit about an axis which is the parallel of latitude at 35°. As each such current whirl passes a given meridian, the ionospheric region oscillates up and down in such a way that the motion in equatorial regions is out of phase with that in high latitudes. Expressed quantitatively, electrons (and ions) in a stream of air moving with velocity c_0 in a direction making an angle φ with magnetic north will acquire a velocity, the vertically downward component of which is given by

$$v = \tfrac{1}{2}\, c_0 \cos\varphi \sin 2I \,.\, \frac{\omega^2}{\nu^2 + \omega^2},$$

where I is the magnetic dip, ν is the electron (or ion) collision frequency and $\omega = He/m$ is the electron (or ion) gyro-frequency.

Since the vertical velocities v of electronic motion due to this effect are not much less than the horizontal tidal air velocities c_0, and since the latter must be larger than the vertical tidal air velocities by several powers of ten, it follows that the ionospheric oscillations due to these electrodynamical causes must be much larger than those due to simple vertical tidal air motions.

A simple test of this conclusion is provided by the study of the phases of the lunar height-variations in the ionospheric layers at high and low latitudes respectively. On the 'electrodynamical theory', these should differ by π (or 6 lunar hours), while on the simple tidal concept no such change should occur from pole to equator. Now Appleton and Weekes[3] have found that the maximum height of the E region in Britain occurs 11·25 lunar hours after transit. This conclusion was obtained from specially accurate measurements made over a period of a year. A study of four years hourly routine height measurements of the same region at Canberra (lat. 35·3° S.) has shown[3] that maximum height occurs in this latitude some five lunar hours after transit. In view of the theoretical importance of the determination of this phase, these studies have now been extended to nine years hourly data at Canberra, and to five years hourly data at Brisbane (lat. 27·5° S.). The results show (for Canberra) maximum h'_E at 4·1 hr. and (for Brisbane) 3·7 hr. after transit. There appears to be no doubt, therefore, that the phase of the lunar height-variation in the E region at these places is substantially in opposition to that in Britain. We may safely conclude, therefore, that the E region lunar oscillations are controlled mainly by the electrodynamical forces described above.

The phases of the corresponding height variations in the F_1 and F_2 regions at Canberra are found[3] to be substantially the same as for E (though slightly later), while the variation in maximum electron density has its maximum about four lunar hours later. In other words, the phases of the lunar height-variations in all the regions are substantially the same at low latitudes. These studies have now been extended to a number of other locations, the provisional findings being shown in the accompanying table. These results, which are derived from some 700,000 hourly values, show that there is no consistent difference of phase in the lunar variations in either the F_1 or F_2 regions in high or low latitudes. (The phases at Huancayo, near the magnetic equator, are anomalous[1], being markedly dependent on solar time.)

At first sight, therefore, it might appear that in the F_1 and F_2 regions, contrary to what has been found in the E region, the lunar oscillations might be of a simple tidal nature. There is little doubt, however, that such a conclusion would be unjustified. A deeper insight is obtained when we remember that each region of the ionosphere cannot be considered as electrically insulated from its neighbours. These regions are linked together by good electrical conduction along the directions of the lines of the earth's magnetic field.

Quantity examined	$h'F_2$			$h'^{\max.}_{F_2}$			$200\int^{\circ}_{F}$ /mean $\int^{\circ}_{F_2}$			$h'F_1$		
Location	P_2	t_2	n	P_2	t_2	n	P_2	t_2	n	P_2	t_2	n
Brisbane	2·5	7·2	15	4·0	5·3	24	3·0	8·8	39			
Burghead, Scotland							2·6	7·6	48			
Canberra	1·6	5·6	48	1·7	5·7	36		9·5	36	0·83	6·1	92
Cape York (N. Australia)	2·0	6·9	11	3·5	6·4	6	4·0	10·1	10			
Christchurch	2·5	5·8	27				2·6	8·5	28			
Durbanville, S. Africa							2·6	11·8	8			
Hobart	2·0	5·3	10	2·2	7·5	9	2·4	9·3	10	1·9	7·5	3
Huancayo (Peru)	2·3	9·2	36	5·2	8·4	30	3·4	4·3	36	0·49*	3·9*	30*
Kihei (Hawaii)	2·6	8·7	15					0·2	14	0·22	7·2	14
Ottawa	0·6	3·2	24					11·4	30	0·15	9·1	18
Washington	3·1	6·0	39				2·8	9·8	41	0·7	6·4	7
Watheroo (W. Australia)	2·0	6·9	73	2·3	4·5	24	2·6	10·4	105	1·3	5·0	21

* These values refer to $h'^{\max.}_{F_1}$.

Amplitude (P_2) (in km. for h), and phase (t_2) (in lunar hours after transit at which maximum occurs), for the semi-diurnal harmonics in the lunar variations of $h'F_2$, $h'^{\max.}_{F_2}$, and $h'F_1$, for various locations. The relative weights to be attached to each determination are indicated by n, which is the number of lunar months of hourly data examined.

It follows that the vertical drift of electrons in a region of weak air tides will be controlled by the *polarization* field of a neighbouring region of strong tides. Thus the phase of the lunar variations in the weaker region will be that appropriate to low latitudes in the stronger region, and will not change in the vicinity of lat. 35°. Theory suggests that viscous damping becomes important between the *E* and *F* regions, so that the tidal *air* motions may be expected to be weaker in the *F* than in the *E* regions. Hence we might anticipate that the phase of the lunar variations in the *F* regions should be that appropriate to the *E* region in low latitudes, as is found.

The observational facts show that the current systems in the F_1 and F_2 regions are quite different from those responsible for the magnetic variations, since they do not change direction near lat. 35°. It follows that the F_1 and F_2 regions cannot contribute appreciably to the lunar magnetic variations. Moreover, any regions of strong tidal movement between the *E* and *F* regions must have a phase opposite to that required to produce the lunar magnetic variations. These results, therefore, provide additional support for the former conclusions[7] that the main seat of the lunar magnetic variations is below the *E* region, and that the integrated currents flowing in the regions from *E* to *F* are in anti-phase to those required to produce the lunar magnetic variations.

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POTENTIATION OF EPINEPHRINE EFFECTS BY FLAVONOID COMPOUNDS

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IT has been suggested[1] that one of the biological roles of substances having so-called 'vitamin P' action is their ability to protect epinephrine (or sympathin) from destruction in the body by combining with copper. This is believed to result in enhanced tone and diminished permeability of the capillaries, with a subsequent amelioration of the hæmorrhagic diatheses for which 'vitamin P' has been claimed to be effective[2]. Many substances, ranging from such simple ones as catechol and pyrogallol[3] to complex glycosides such as rutin[1,4], have been reported as potentiating epinephrine-mediated effects on isolated organs and in intact animals. An examination of the structure of those substances which have been reported to be effective in decreasing capillary fragility or permeability suggests that there may be no common mechanism of action of these substances.

In order to isolate for detailed study one of the effects claimed for many of the 'vitamin P'-like substances, an examination has been made of some seventy compounds for their ability to increase the duration of the relaxation of the isolated mammalian intestinal segment by epinephrine in the presence of cupric ion; nineteen of the fifty or so flavonoid substances tested were prepared or synthesized by one of us (T. A. G.). One microgram of copper sulphate per ml. of Tyrode's solution was found optimal for eliminating a certain lack of reproducibility of the epinephrine responses, which were erratic in its absence, due probably to the presence of small but inconstant amounts of copper in the water, the salts used in the Tyrode's solution or the substances being tested. Without cupric ion, some of the inhibitors tested prolonged the epinephrine response so markedly that it became impossible to compare their activities. A number of compounds known to enhance the effect of epinephrine on isolated smooth muscle[3,5] were included in the study. Rutin (quercetin-3-rhamnoglucoside) was selected as the reference substance of unit activity. The procedure will be described in detail elsewhere.

The following compounds exceeded the activity of rutin four times or more on a mole-equivalent basis: gossypetin, 3,3′,4′-trihydroxyflavone, quercetin sulphonic acid, 8-hydroxyquinoline, quercetin, glutathione and 2′,3,4-trihydroxychalcone.

The following had an activity of more than one but less than four times as great: sodium diethyldithiocarbamate, 3′,4′-dihydroxyflavone, cysteine hydrochloride, gossypin, gossypitrin, butein, quercetagetin, esculetin, pyrogallol and 3,4-dihydroxychalcone.

The following had the same activity as rutin: 'BAL' (2,3-dithiopropanol), cyanin-chloride, rutin (standard unit), leptosin and *nor*dihydroguaiaretic acid.

The following had about half the activity of rutin: 3′,4′-dihydroxyflavanone, epimerized *d*-catechin, *d*-catechin, *l*-epicatechin, 3-hydroxy-3′,4′-dimethoxyflavone, chlorogenic acid, 2′,3′,4′-pentahydroxychalcone, 5-hydroxyflavone, ascorbic acid and xanthorhamnetin.

Of negligible activity were: eriodictyol, 4,4′-dihydroxychalcone, disalicylalethylenediimine, 3,5,7,3′,4′-pentahydroxyflavanone, hesperetin, 7,8,3′,4′-tetrahydroxyflavanone, dihydroesculetin, phloretin, disalicylal-*o*-phenylenediimine, esculin, rutin phthalate and succinate, 3,4′-dihydroxy-4-methoxychalcone-4-glucoside, sodium-α-tocopherol phosphate, 2′-hydroxychalcone, 2,4′,6′,3,4-pentamethoxychalcone, hesperidin, hesperidin phthalate and succinate, 'methylated hesperidin chalcone', 'acetylated hesperidin chalcone', hesperidin 3′-ethylcarbonate, naringin, *o*-hydroxyacetophenone, 4′-aminochalcone glucoside, 3′,4′-dihydroxy-4-methoxy-chalcone-4′-phosphate (di-sodium salt), butrin and inositol.

'Citrin', prepared according to Szent-Györgyi and by modifications thereof, could not be assayed on a mole-equivalent basis because of its unknown structure; but assuming a 70 per cent purity and

that it may be related to eriodictyol rhamnoside[6], it has an activity of about 0·2 that of rutin. On a weight basis it is less than half as active.

Pomiferin and gossypol were tested, but were too insoluble. Catechol, hydroquinone and resorcinol accelerated the destruction of epinephrine.

The most active compound was gossypetin, a flavone with an activity 16·0 times that of rutin (on a weight basis). This was followed closely by 3,3′,4′-trihydroxyflavone (15·5) and quercetin (10·0).

The results are in accord with the activity series reported by Lavollay[7], who used a similar method. The most active of the seven compounds he tested was quercetin. Lavollay[8] also showed by manometric and colorimetric methods that the autoxidation *in vitro* of epinephrine was inhibited more by quercetin than by rutin or rhamnetin, and that naringin had low activity. He and his co-workers claimed a close parallelism between the results obtained by the smooth muscle assay and those by the autoxidation studies *in vitro*. Using an improvement of his colorimetric method, we could not confirm this parallelism in a more extensive series of compounds tested.

The present study shows that the common structural feature of the active substances is a grouping capable of forming complexes with heavy metals; and for those pairs of substances with closely similar structures, the more active forms a more stable complex. Although many of the active substances contain the *ortho*-dihydroxybenzene nucleus, this structural element does not appear to be a necessary condition for activity, since 8-hydroxyquinoline, 3-hydroxy-3′,4′-dimethoxyflavone and 5-hydroxyflavone show activity in varying degree. (Bartlett[9], working in these laboratories, has indicated that inhibition of succinoxidase by 2′,3,4-trihydroxychalcone is due to quinone inhibition of sulphhydryl groups and that quinoid effects on proteins in general, of related *ortho*-dihydroxybenzene compounds, should be borne in mind in biological studies of these compounds. When the *o*-dihydroxy groupings were substituted (for example, methylated), no inhibition occurred, presumably because the quinoid structure could not form. However, in the body, it is conceivable that phenyletherase activity could cleave the carbon–oxygen bond of phenyl ethers, and thus, for example, demethylate hesperidin derivatives[10].) The presence of a potential chelate-forming grouping, on the other hand, is not a sufficient condition for activity, since hesperidin, hesperetin, phloridzin and 2′-hydroxychalcone show negligible activity; yet the first two of these have been shown by polarographic studies to chelate readily with copper[11].

A conspicuous result of this study is the demonstration that there is no correspondence between the reported biological and clinical activity of many of these compounds on capillary fragility and their activity in this assay. It is evident that the studies should be extended to the intact animal in further attempts to relate sympathomimetic action and capillary fragility. Experiments in this direction are under way in these laboratories.

A complete report of these studies will be given elsewhere.

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TRAWLING SURVEYS IN PATAGONIAN WATERS

THROUGHOUT the whole of the cold-temperate (sub-Antarctic) zone of the southern hemisphere the waters overlying the Patagonian continental shelf provide the largest expanse of sea shallow enough to support a considerable population of commercial fishes. During the years 1927, 1928 and 1931–32 the Discovery Committee's research vessel *William Scoresby* carried out three trawling surveys of this region between latitudes 42° S. and 52° S. The primary object of the investigations was to provide information upon which the prospects of carrying on a commercial fishery from the Falkland Islands could be assessed. The results of these surveys have now been published in a scientific report* of considerable importance by Dr. T. John Hart, biologist on the Discovery Committee's scientific staff. Dr. Hart did not himself carry out the surveys (though he has had some experience of field-work in that region), and the results have been written up mainly from manuscripts left by the late E. R. Gunther who, unfortunately, did not live to complete them. In these circumstances the task of picking up the threads and collating the data involved much difficulty, and Dr. Hart often found it necessary to start afresh from the original data. The substance of the report is therefore the combined work of Gunther and Hart, but the latter has written the entire text in its final form.

The first part of the report is devoted to the general topography of the shelf, with sections on hydrology and plankton. The Patagonian continental shelf stretches from the River Plate in the north to Staten Island in the south, and extends off-shore to an average distance of some 200 miles to the eastward. There are uniformly moderate depths over the plain of the shelf with a very easy depth gradient from the 80 m. to the 200 m. contour which may be taken

* Discovery Reports. Issued by the Discovery Committee, Colonial Office, London, on behalf of the Government of the Dependencies of the Falkland Islands. Vol. 23. Report on Trawling Surveys on the Patagonian Continental Shelf, compiled mainly from Manuscripts left by the late E. R. Gunther. By Dr. T. John Hart. Pp. 223–408. (Cambridge: At the University Press, 1946.) 35s. net.

as outlining the shelf 'edge' beyond which the descent to oceanic depths is relatively abrupt. Rough ground with 'corallines' and coarse deposits prevails in the southern part of the area surveyed, while finer deposits are present farther north, providing better conditions for trawling. The main current affecting the area is the relatively cold Falkland current flowing from south to north, and coldest along its off-shore margin. The warm Brazil current impinges upon this, offshore, in the extreme north-east of the area, where the hydrological conditions may be very complex; but they are normally too far out to affect conditions on the shelf to any important extent. On the inshore flank of the Falkland current (which is a movement of sub-Antarctic surface water) the flow is less strong, so that 'old shelf water' is warmed and sometimes even flows southward as a small intermittent counter-current close in to the land. This seems to have an important effect on the distribution and movements of some of the fishes. The annual cycle of surface temperatures is centred lower than in corresponding latitudes in the northern hemisphere, with the peak after mid-summer, and the annual range is small. At greater depths the temperature range is still smaller and the time-lag between air and sea temperatures is even greater, so that bottom temperatures are highest in autumn and lowest in spring or even early summer.

Some preliminary observations on plankton are discussed, but the large collections obtained have not yet been worked up. The same is true of the benthos. Nevertheless, some fairly firm conclusions have emerged. The general facies of the plankton is closely similar to that found in cold-temperate waters in other parts of the world, but the onset of the main phytoplankton increase falls later in the year than in corresponding latitudes in northern hemispheres, especially towards the outer edge of the shelf. Dependent cycles of higher organisms are therefore also centred later in the year. This in turn affects the largest nekton (fish and squids) in that some at least show a similar 'lateness' in their biological seasons. Species, apparently corresponding to spring spawners elsewhere, spawn about mid-summer in this region, while hake, which in other regions are chiefly summer spawners, ripen here mainly in autumn.

The second and larger part of the report deals mainly with the demersal fish fauna. It was found that the Patagonian continental shelf is notably poorer in species than are roughly comparable areas elsewhere. Two Merluccidæ, a true hake (*Merluccius hubbsi*) and the 'long-tailed hake' (*Macruronus magellanicus*), were dominant among the larger fishes; and particular attention is devoted to them in the report, which deals in a detailed manner with the relative sizes of Patagonian and European hake, the distribution and relative abundance of *Merluccius hubbsi* within the area surveyed, the relationship between length and weight of this species and its value as an indicator of the spawning season, food and feeding, and the effect of latitude on numbers, size and sex ratio. *Macruronus magellanicus* is treated similarly, but slightly less fully, and the main features of the bionomics of the two species are summarized in a very useful table (p. 320).

The principal conclusion of the report is that, although the shelf is not very rich in trawlable fish, hake and some other edible species are present in moderate numbers. Unfortunately, the best trawling grounds are not very near the Falkland Islands. Nevertheless, the report shows quite clearly that, on the shelf to the northward, roughly equidistant from the Falkland Islands and the lesser Argentine ports, there is a stock of hake just sufficient to enable a modern trawler to pay its way *if there were markets equivalent to British ones within a few hundred miles*. It is pointed out, however, that the population of the Falkland Islands is too small and too scattered to enable a suitable trawler to pay its way on local trade alone. Whether or not trawling can ever be developed would appear to depend, therefore, upon the growth of a demand for fish at an economic price in the Argentine as well as in the Falklands. Dr. Hart's report shows quite clearly that the raw material for the development of a trawl fishery, at any rate on a small scale, is present on the Patagonian shelf. It is now the task of the administrators and technologists to investigate and assess the prospects of exploiting them.

G. A. Steven

ASTRONOMICAL OBSERVATIONS IN AUSTRALIA

Dr. R. v. d. R. Woolley, Commonwealth Astronomer of Australia, has issued a report covering the period January 1–December 31, 1947, the state of the Observatory at Canberra being represented on the latter date. The report includes the work carried out in fifteen different sections, and the following short summary deals with only a few of the main investigations that are described.

Under solar investigations are included, in addition to a description of the observational work, certain theoretical investigations. Baumbach's estimate of the electronic density in the corona has been recomputed, allowances having been made for the scattering of the Fraunhofer coronal spectrum by dust and not by electrons, and it appears that the degree of ionization in the corona is caused by collisions with electrons at one million degrees C. In addition, the composition of the corona is shown to be similar to that of other cosmic sources, and the ratio of the number of hydrogen atoms to that of the metals is 6,000 : 1. The collision excitation cross-section of the coronal line has been measured by observation, and the coronal emission in discrete lines, and in continua has been computed. Under astronomical observations are included, among others, the following: the programme of observations of position angle and separation of double stars with the 9-in. Oddie refractor; work on the determination of the stellar magnitudes of the sun, involving spectrophotometry of the light from a weakened solar image and from Sirius; variable-star investigations for which an electron-multiplier photometer was installed at the Farnham telescope and used to examine the light from several stars known to be spectroscopic variables, but which had not been reported as light variables; monochromatic photometry of brighter stars, using a commercial interference filter which, however, proved unsuitable, as it was transparent outside the nominal transmission band, and hence other methods were tried, as a result of which permanent apparatus for this work is now under construction; and the determination of stellar photometric gradients by using a slitless spectrograph for the Reynolds reflector. In connexion with this last programme, it is pointed out that, as the southern hemisphere is

about four times as rich as the northern in bright, early *B* stars, the determination of accurate gradients and spectral types for these stars should assist materially in the elucidation of the present uncertain colour spectrum relation from *O* to *B*3. This is a matter of fundamental importance in studying interstellar reddening and galactic structure in general.

Approval has been received for the acquisition of a 74-inch reflector as recommended by the Astronomer Royal when he visited the Observatory in February 1947, and, while negotiations have been opened with Sir Howard Grubb, Parsons and Co., Ltd., for the construction of an instrument similar to the Radcliffe telescope, a final contract has not yet been arranged. All the smaller mirrors attached to the Observatory have been aluminized by means of the N.R.C. evaporating plant obtained from the Munitions Department, which has also supplied a 42-inch aluminizing tank; this should enable all the existing glass mirrors in the Observatory to be aluminized.

The Ionospheric Prediction Service, which had previously been operated by the Radio Research Board, has been transferred by that body to the Department of the Interior, and attached to the Commonwealth Observatory. It issues two monthly publications—"Radio Propagation Bulletin" and "Tables of Frequency Bands to be used by Ships and Aircraft for Communication with Australian Bases"—and also an annual report on long-term forecasting.

MITES AND STORED FOOD PRODUCTS

THE mites associated with stored food products have received much less attention from biologists than the insect pests found with them. For one thing, students of Acari are few, and mites are often hard to identify. Also, much of the leading systematic writings on these creatures has been published in various languages and in journals that are often very inaccessible. Under the title of "The Mites Associated with Stored Food Products"*, Mrs. A. M. Hughes has written a useful paper that has recently been issued on behalf of the Ministry of Agriculture and Fisheries. The Department of Scientific and Industrial Research inaugurated a study of the biology of mites, while the Ministry of Food stationed an officer, Mrs. M. Kendall, at the British Museum (Natural History) to study their systematics. She was followed in this work by Mrs. A. M. Hughes, of the Royal Free Hospital School of Medicine, who was deputed to work on a part-time basis attached to the Infestation Division of the Ministry of Food. This latter Division, it may be added, was transferred to the Ministry of Agriculture and Fisheries in September 1947.

If food be kept in store for any length of time, mites are very liable to infest it and increase to incredible numbers, contaminating it with their excreta and dead bodies. The present publication deals with the mites that affect stored food products, together with the kinds that prey upon them. Also included are certain mites that feed upon small fungi or are parasites on insects or rats. While the biology of many of the mites that are enumerated is unknown, the present descriptive account will serve as a guide to their identification and, thereby, provide the basis for more extended investigations. The segmentation of the body in mites is peculiarly developed, which makes it difficult to homologize the regions thus demarcated with corresponding areas in other Arthropoda. For this reason, new names are given to the different regions of the body that are displayed in these creatures.

Three sub-orders of mites are recognized, namely, the Sarcoptiformes, Trombidiformes and Parasitiformes. Of the first-named group the Tyroglyphoidea cause the most severe damage. They are small whitish mites occurring in all kinds of stored products when the relative humidity of the immediate environment is 70 per cent or more. Among their members one of the commonest is *Glycyphagus domesticus*, which not only affects dried food materials but often occurs in enormous numbers in furniture stuffed with untreated Algerian fibre, where it feeds on fungi growing on the fibre. Among the Trombidiformes are many brightly coloured mites, including the familiar 'red spiders'. Some of them are represented in the stored product fauna, where they are predaceous upon other mites or on small insects. The Parasitiformes are highly specialized mites that are divided into the two groups, Ixodides, which do not affect stored products, and the Mesostigmata, which prey upon other mites, insects or small mammals, such as rats and mice.

When collecting mites the use of Oudemans' mixture is advised in preference to spirit or formalin. For temporary mounts a 60 per cent solution of lactic acid is satisfactory, while for more permanent preparations a mixture of polyvinol alcohol and lactophenol is better than gum chloral for small species. The composition of these several media is given at the end of the bulletin. There is also a short list of the essential literature dealing with the various groups of mites. The accounts given of the different species are very concise and their value is enhanced by the very numerous figures of structural details.

A. D. IMMS

* The Mites Associated with Stored Food Products. By A. M. Hughes. Pp. 168. (London: H.M. Stationery Office, 1948.) 3s. net.

FORTHCOMING EVENTS

Monday, January 3

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Dr. E. Holmes: "Weed Control".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 2.30 p.m.—"Bush Christmas" (Sound Film). (Christmas Meeting for Young People.)

Tuesday, January 4

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Lieut. P. G. Satow: "Radar and its Application to the Science and Art of Marine Navigation".

Wednesday, January 5

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL OF THE FOOD GROUP (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6.30 p.m.—Discussion on "The Sausage as Food".

INSTITUTE OF WELDING, MANCHESTER AND DISTRICT BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. R. R. Sillifant: "Recent Developments in Oxygen Cutting".

Friday, January 7

TEXTILE INSTITUTE, LANCASHIRE SECTION (at the Textile Institute, 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. L. W. Coxon: "The Philosophy of Management".

SOCIETY OF CHEMICAL INDUSTRY, MANCHESTER SECTION (joint meeting with the LOCAL SECTIONS of the CHEMICAL SOCIETY and the ROYAL INSTITUTE OF CHEMISTRY, at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Dr. H. Steiner: "Production of Acetylene from Hydrocarbons".

PAPER MAKERS' ASSOCIATION, TECHNICAL SECTION, NORTHERN DIVISION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. H. R. Hutley: "The Technical Education of Juveniles in the Paper Industry—Practical Considerations".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMIST (with suitable research experience) to take part in an investigation of tissue proteins—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3 (January 11).

SENIOR PRINCIPAL SCIENTIFIC OFFICER, or PRINCIPAL SCIENTIFIC OFFICER, at the Royal Greenwich Observatory, Herstmonceux—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, S.W.1, quoting No. 2344 (January 13).

GLASS BLOWER in the Department of Natural Philosophy (Physics), United College—The Secretary, The University, St. Andrews (January 15).

ASSISTANT PHYSICIST—The Secretary, Sheffield National Centre for Radiotherapy, 18 Tree Root Walk, Sheffield 10 (January 15).

LECTURER IN SOCIAL PSYCHOLOGY—The Registrar, The University, Manchester 13 (January 21).

PROFESSOR OF PURE MATHEMATICS, and a PROFESSOR OF APPLIED MATHEMATICS, in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (January 31).

SENIOR RESEARCH OFFICER—CHEMIST, and a MECHANICAL ENGINEER, in the Sugar Milling Research Institute, Durban—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (January 31).

CHAIR OF GEOGRAPHY in Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 32 Woburn Square, London, W.C.1 (February 1).

LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN MATHEMATICS—The Principal, Heriot-Watt College, Edinburgh (February 8).

CHAIR OF LEATHER INDUSTRIES—The Registrar, The University, Leeds 2 (February 14).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool (February 26).

AGRICULTURAL CHEMIST IN THE DEPARTMENT OF AGRICULTURE, Sierra Leone—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

CHIEF ASSISTANT to the Head of the Chemistry Department—The Director, Linen Industry Research Association, Lambeg, Co. Antrim.

LECTURER IN PHYSICS AND MATHEMATICS in the Municipal Technical College, St. Helens—The Director of Education, Education Office, St. Helens.

ASSISTANT PHYSICIST—The Secretary to the Committee, Christie Hospital and Holt Radium Institute, Manchester 20.

BOTANISTS (with a University degree in botany, at least two years' post-graduate experience, and a knowledge of plant breeding and genetics) in the Department of Agriculture, Uganda—The Director of Recruitment, Colonial Service, Colonial Office, Great Smith Street, London, S.W.1.

INSTRUMENT MAKER AND LABORATORY TECHNICIAN IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Clerk and Treasurer, Dundee Institute of Art and Technology, Bell Street, Dundee.

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Secretary, Royal Technical College, Glasgow.

LABORATORY STEWARD IN THE SCIENCE DEPARTMENT, Constantine Technical College—The Director of Education, Education Offices, Middlesbrough.

PLANT PATHOLOGIST IN THE DEPARTMENT OF AGRICULTURE, Trinidad—The Director of Recruitment, Colonial Service, Colonial Office, Great Smith Street, London, S.W.1.

WORKS PHYSICISTS (to be responsible for radiation monitoring carried out by the factory health physics department) in the Division of Atomic Energy (Production), Windscale Works, Sellafield, Cumberland—The Staff Section, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington.

GRADUATE RESEARCH WORKER to take part in an investigation into the structure of the dental tissues in health and disease, by means of the electron microscope—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER in a Ministry of Supply research and development establishment near London, for work on the design of specialized equipment in glass and metal for chemical and chemical engineering projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.1026/48A.

PHYSICIST (with considerable experience of radiotherapy) to collaborate in clinical research with ionizing radiations and radioactive isotopes—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12.

JUNIOR SCIENTIFIC WORKER (with B.Sc. or medical or veterinary qualification) to assist in the biological side of work on chemotherapy and resistance factors in experimental tuberculosis, at the National Institute for Medical Research Farm Laboratories, Mill Hill, London, N.W.7—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

SCIENCE GRADUATE (young) to assist in the application of electron microscopy to textile problems—The Director of Research, Shirley Institute, Didsbury, Manchester 20.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Admiralty Ship Welding Committee. Report No. R.3: The Fracture of Mild Steel Plate. By Dr. C. F. Elam Tipper. Pp. ii+42+40 plates. (London: H.M. Stationery Office, 1948.) 6s. 6d. net. [268

Some Welsh Fungi: a Guide to the Collection of Models in the Department of Botany. By Eveline A. Jenkins. Pp. vi+50. (Cardiff: National Museum of Wales, 1948.) 2s. 6d. [268

The Irrationality of 'The Irrational' especially as regards the Delusion of (what is called) 'General Relativity' (though not similarly Special Relativity) (illustrated in the Matter of Mercury's Perihelion and otherwise). By Arthur Lauck Parson. Revised. Pp. ii+44. (Maryport, Cumberland: The Author, Allonby, Mawbray Road, 1948.) [306

Copper Compounds in Agriculture and Industrial Microbiology. Pp. 117. (London: Copper Development Association, 1948.) Free. [306

Health and the Soil. (Quarterly.) Summer 1948. Pp. 60. (Edinburgh: Health and the Soil, 48 Manor Place, 1948.) 2s. 6d.; annual subscription, 10s. [306

Department of Scientific and Industrial Research: Forest Products Research. Special Report No. 7: The Elasticity of Wood and Plywood. By R. F. S. Hearmon. Pp. 88. (London: H.M. Stationery Office, 1948.) 2s. net. [308

Ministry of Health. Report of the Departmental Committee on Greater London Water Supplies. Pp. ii+16. (London: H.M. Stationery Office, 1948.) 3s. 6d. net. [18

Hospital and Community. 1: Hospital-treated Sickness amongst the People of Stirlingshire. Pp. xii+96. (London: Nuffield Provincial Hospitals Trust, 1948.) 3s. 6d. [19

Proceedings of a Colloquium on the Industrial Utilisation of Agricultural Products and of Seaweed, Dublin, 2nd and 3rd July, 1947, under the joint auspices of the Irish Chemical Association and the Dublin Section of the Royal Institute of Chemistry. Pp. 72. (London: Royal Institute of Chemistry, 1948.) 5s. [29

Major Diseases of the Cultivated White Mushroom. By Fred C. Atkins. Pp. ii+10. (Yaxley, Peterborough: Midlands Group Publications, 1948.) 2s. 6d. [29

Agricultural Research Council. Report Series No. 7: The Spread of Virus Diseases in the Potato Crop. Pp. viii+189. (London: H.M. Stationery Office, 1948.) 5s. [69

Anti-Locust Bulletin 1: Recent Advances in Acridology; Anatomy and Physiology of Acrididae. By Dr. B. P. Uvarov. Pp. 75. 24s. Anti-Locust Bulletin 2: Laboratory Studies on the Spraying of Locusts at Rest and in Flight. By Dr. J. S. Kennedy, M. Ainsworth and Dr. B. A. Toms. Pp. 64. 7s. (London: Royal Entomological Society of London, 1948.) [69

Forestry Commission. Twenty-eighth Annual Report of the Forestry Commissioners for the Year ending September 30th, 1947. Pp. 68. (London: H.M. Stationery Office, 1948.) 1s. 3d. net. [69

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1947. Pp. 243. (Bristol: The University, 1948.) [68

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 833, Vol. 241: The Emission of Light charged Particles in the Slow Neutron Fission of Uranium. By L. L. Green and D. L. Livesey. Pp. 323–343. (London: Cambridge University Press, 1948.) 6s. 6d. [69

The Glaxo Volume: an Occasional Contribution to the Science and Art of Medicine. 1. Pp. 48. (Greenford: Glaxo Laboratories, Ltd., 1948.) [79

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 601, Vol. 233: The Structure of certain Jurassic Holostean Fishes, with special reference to their Neurocrania. By Dr. Dorothy H. Rayner. Pp. 287–345. (London: Cambridge University Press, 1948.) 19s. [99

Other Countries

Thirty-first Annual Report of the National Research Council of Canada, 1947–48. (N.R.C., No. 1766.) Pp. 26. (Ottawa: National Research Council, 1948.) [248

Bergedorfer Spektral-Durchmusterung der 115 nördlichen Kapteynschen Eichfelder. Von A. Schwassmann und P. J. van Rhijn. Band 3: Eichfeld 44 bis 67, Deklination +30°. Pp. D56+344. (Bergedorf: Hamburger Sternwarte, 1947.) [308

Indian Journal of Dairy Science. (Official organ of the Indian Dairy Science Association, published quarterly.) Vol. 1, Nos. 1 and 2, March and June 1948. Pp. iii+48. (Bangalore: Indian Dairy Research Institute, 1948.) 3 rupees; annual subscription, 12 rupees, 20s. [318

Some Salient Features of the New Zealand Native Flora. By William C. Davies. (Banks Lecture, 1947.) Pp. 16+20 plates. (Nelson, N.Z.: Cawthron Institute, 1948.) 2s. [318

Atomic Energy. By Prof. P. W. Burbidge. (Cawthron Lecture, 1946.) Pp. 14+3 plates. (Nelson, N.Z.: Cawthron Institute, 1947.) [318

Problems in Astronomy Solved and Unsolved. By F. G. Gibbs. (Cawthron Lecture, 1947.) Pp. 20. (Nelson, N.Z.: Cawthron Institute, 1947.) [318

Federal Security Agency: Office of Education. Bulletin 1948, No. 1: Education in Haiti. By Prof. Mercer Cook. Pp. vi+90. (Washington, D.C.: Government Printing Office, 1948.) 25 cents. [29

Smithsonian Miscellaneous Collections. Vol. 110, No. 8: The Behaviour of Barometric Pressure during and after Solar Particle Invasions and Solar Ultraviolet Invasions. By B. Duell and G. Duell. (Publication 3942.) Pp. ii+34. (Washington, D.C.: Government Printing Office, 1948.) [69

Smithsonian Miscellaneous Collections. Vol. 110, No. 10: The Feeding Organs of Arachnida, including Mites and Ticks. By R. E. Snodgrass. (Publication 3944.) Pp. ii+93. (Washington, D.C.: Government Printing Office, 1948.) [99

La Aeronáutica Nacional al Servicio del País. Pp. 347. (Buenos Aires: Secretaría de Aeronáutica de la Nación, 1948.) [99

East African Industrial Research Board. Fifth Annual Report, 1947. Pp. iii+28. (Nairobi: East African Industrial Research Board, 1948.) 1s. 6d. [149

Union of South Africa: Department of Mines, Geological Survey. Memoir No. 42: Diatomaceous Deposits in the Union of South Africa, with special reference to Kieselguhr. Part 1: Geology and Economic Aspects, by L. E. Kent; Part 2: The Diatom Flora, by the late Dr. A. W. Rogers. Pp. ii+260. (Pretoria: Government Printer, 1947.) 10s. [149